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PRAY'S

STEAM TABLES

AND

ENGINE CONSTANTS.

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53

PRAY'S

STEAM TABLES

AND

ENGINE CONSTANTS.

For facilitating all Calculations upon Indicator Diagrams, or Various Problems connected with the operation of the Steam Engine, from reliable data and with precision.

COMPILED FROM REGNAULT, RANKINE AND DIXON,
DIRECTLY, MAKING USE OF THE EXACT RECORDS.

EVERY TABLE IN THIS WORK WAS COMPUTED, NOT COPIED.

BY

THOMAS PRAY, JR., C. C. & M. E.
MEMBER OF MANY SOCIETIES, ETC.

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PREFACE.

The necessity of a book of Tables of the properties of Steam, in which some of the most used factors should be grouped not alone in a convenient way for reference, but with some certainty of reliability, has been experienced by every Engineer who has had active practice in Steam Tests, especially of the last few years or since we have been using pressures of exceeding One Hundred and Fifty pounds per square inch.

It may have been true to some extent that such tables have been accessible, but in too many cases some opinion had been interjected into their computation, or, as has often been announced, "corrections of apparent errors," have caused quite too much of error, and no end of discussion and trouble when different Engineers were on the same work, and not using the same tables. The amount of detail and the settlement of the fact that Indicator springs are as incorrect as the average steam tables have been, has introduced cause for another correction, that calls for an accuracy beyond the old idea of a single place decimal, or that "about," was at all an approach to accuracy. The immense amount of labor in recent tests of new steamship engines, where one pound of mean pressure was of a contract value of Forty Thousand Dollars, or in some of the writers' pumping engine tests, where the density of steam had an item of the least error, being multiplied by *billions*; or where some fraction of a pound of pressure had the same multiplier, or the evaporation factor was counted from a low temperature to 380° F. and especially when the areas of circles in well-known text books have varied from the fact, to several inches of error in the area of a small piston. These are some of the abstract reasons why the writer has from time to time considered the putting of his own needs into such a form that one set of covers would hold all information, not only in a convenient but in accurate form, and so that frequent computations could be made with close accuracy, and with the least amount of reference to outside sources, and utmost certainty of final result.

If some of the often-followed practices have been discarded, it is for good reasons, this will be noticed in the "Steam Table of Fahrenheit Degrees," in which the absolute pressure is given for each degree, in place of the Temperature for each exact pound, we scarcely ever in practice, read pressures at exactly even pounds, and if the standardized Thermometer is used properly, it is a check on any steam gauge, and far more accurate, for no such thing is to be had or found as a correct steam gauge anywhere, hence a way of settlement of the important factor is offered by using the thermometer, as check, and getting at once the actual temperature and steam pressure in pounds per square inch, and no "steam gauge correction" factor in the computation. It is as easy to work and better than as usually done.

The density of steam is correctly given in this volume, taking Prof. Rankine as reliable, and no one to-day has the abstract facts on that property of saturated steam to any greater certainty than he had, and up to date no one has given facts to consider in place of his reasoning, nor with any approximate basis beyond their own conception of what might be. The tables here given will, to some extent, increase the amount of steam used in any place, but it is correct from present knowledge, and with Regnault's observations and results, and Rankine's verifications of those same results, we must be put in possession of far more accurate data, than the suppositions of theorists, before we attempt to alter the Rankine basis, for saturated steam, for the simple, but indisputable reason that his basis was entirely from Regnault's actual experiments, in using steam, under practically the same conditions that steam engines use it in practical work, while the density is assumed to a great degree in any case, the basis herein adopted is assumed only so far as the higher pressures are given, it is almost positively known for some of the lower range.

The objection to Prof. Rankine's work is often urged that he makes "such jumps," and it is true that his reasoning shows an impatience of detail, not shown by Regnault, yet Rankine in his, as Prof. DeVolson Wood says, "giant strides," has laid down what so far has not been found to vary from the fact in practice, when the facts have practically been determined, and his work stands with the least question, of anything in its line, but his work is full of places where a search has to be made to secure continuity, and in much of his reasoning, whoever would understand it, must do some reasoning on his own account to connect, and by searching this out, it is surely there, and is then clear.

Rankine had as prodigious a power of reasoning, from analytic basis, as Regnault had of patient accuracy of observation, the former often shows his impatience, to some detail, and the latter in his published work, is as calm as though intricate problems, and notes of disturbing elements, were a part of his life, or work at least; and if his critics were only a fraction, in comparison, as painstaking as he was, or if they looked out clearly *all* the elements he had considered, in their attempts to show where he had made some error, we should not have so many claims of "improved Regnault" and less fog around his results, which are not in the least disturbed by criticism, and the whole of our actual knowledge of steam, as to its properties, hinges on Regnault's observations, and Rankine's demonstrations on the theory and practice, taken partly from his theory, and based on Regnault's experimental data.

In the most accurate attempts to repeat Regnault's experiments, so far as they are of sufficient worth to record, the differences found, are in the sixth or seventh place of the logarithm, and in some cases farther than that, but as we do not measure either millionths or ten millionths of a degree, or pound, it is safe to adhere to the accuracy of these two men's work, and still consider that we have no basis as near as that which they have left us.

The author has a full translation of the important papers of Regnault now nearly ready to publish and it will follow this volume with only a short interval.

The bringing together in one book of the important elements of testing work, in the present form, has been the author's intention since his work on the U. S. Cruiser "Baltimore," in '89, and which was the first case in this country in which the proper corrections have ever been made to reduce temperature, latitude, gravity and expansion, to abstract fact, in a commercial way.

From that time to this he has rearranged and adjusted far larger ships' engines, and makers of instruments are now making some efforts to correct their standards, but the real importance of fully corrected Steam Gauges, Indicator Springs, and computations are not even now considered either by makers or users.

The computations in this book have been made entirely by the author and his son Robert, as opportunity has allowed, intervals of months, when on important work, have occurred; then a rest of a few days and some work done, it has progressed slowly, and no one, where so much comparison in the record is needed, has an idea of the amount of work necessary, the results are completely recomputed, in each detail, nothing has been taken that was not proved, and it is offered as embodying in compact form, the most used data for computations for boiler testing, duty performance of pumping engines, and the many inquiries of an indicator diagram, its intention has in all respects been to be accurate, "within the limits of observation," and no theories of any kind have been considered or expressed intentionally.

To some extent this work is an answer to the hundreds of letters received referring to "Twenty Years," and the inquiries from its twelve thousand purchasers, as to some of the ways to compute the much needed data on cards, or other usual queries of steam plants.

THOS. PRAY, Jr.

Boston, Mass., April 5, 1894.
P. O. Box 2728.

RATIO OF EXPANSION, CUT-OFF.

HYPERBOLIC LOG+1.

Constant for Mean Exerted Pressure, at any initial pressure and any point of cut-off, for "Dry Saturated Steam." See pp. 21, 22.

Read across the page in all computations.

Column 1 is the cut-off in hundredths of the stroke.
" 2 is Ratio of Expansion for cut-off in Column 1.
" 3 is Hyperbolic Log+1 of Ratio of Expansion in Column 2.
" 4 is Vega's Logs. of Column 3.
" 5 is K (constant) for mean exerted pressure at cut-off in Column 1.
" 6 is Vega's Logs. of Column 5.

Col. 1, the "cut-off," or the point at which the valve was entirely closed, best found by the theoretical demonstration in "Twenty Years," pp. 143 to 147, inclusive, and to be correct should always include the clearance or volume of all the space between the piston head and the valve as closed; this is only found by measurement, and to reduce the actual clearance to its proportion of the space swept through by the piston, it is far better to go to the trouble of filling the space with water and weighing it, and to reduce any amount of water at any temperature into square inches, turn to the table on the "Heat of Water," page 23, and find the number of cubic inches of water in one pound at any temperature from 32° F. to 212° F., and the clearance space in any engine can be reduced into cubic inches of space, with a single operation.

It must be remembered that clearance, if *not* considered, has a certainty in that it reduces the ratio of expansion, and in not computing it the results are certainly incorrect. When the results of clearance are computed as directed in this table, the *actual* cut-off is point of computation, and the result is correct, being in all cases the mean exerted absolute pressure, and for a *non*-condensing engine, the value of the atmosphere must, in all cases, be added in computing, and the absolute initial pressure must be taken as a starting point; the atmospheric pressure is to be deducted after the result is obtained. For condensing engines, use the absolute initial pressure as starting point and drop the atmospheric pressure in computing.

Col. 2, "the ratio of expansion." for the cut-off in column 1, or the ratio of the expanded steam to the amount let into the cylinder before the cut-off took place.

Col. 3, "Hyperbolic Log+1," of the Ratio of Expansion, in column 2 (the ε denotes the use of the hyperbolic logarithm), and any number in column 3 shows the proportion of work done, before expansion and during expansion, or the total amount; taking .01 the ratio of expansion is 100. and $\varepsilon+1.=5.605$, from which take 1 and the work done before expansion is denoted by the 1 and *during* expansion, 4.605 times as much is done as before the cut-off took place, and the total is $1.+4.605=5.605$, or, as it is sometimes written, the 1 represents the initial work of the steam at any pressure, and the 4.605 what is done during expansion, or after the cut-off valve has completely closed (supposing that all valves are tight and the steam is "dry saturated," or has in it only a small amount of moisture, as less than 2½%).

This is one of Prof. Rankine's formulæ, and is written by him as $pm=pi\ (1+\varepsilon r)\div r$, or that the mean pressure of any diagram is equal to 1., plus the hyperbolic log. of the ratio of expansion, multiplied by the initial pressure, that product divided by the rate of expansion, the result being the absolute mean pressure, and this result is all that can be done by the steam, and is used to ascertain quickly the percentage of work actually accomplished by the engine, compared with the theoretical. The result of this table will be "theoretical." Example—102 lbs. by steam gauge cuts off at .31 of the stroke, engine non-condensing, then $102+14.7=116.7$ for absolute pressure, the ratio of expansion for $.31=3.226$ and the $\varepsilon+1$ is 2.171, then $116.7\times2.171\div3.226=78.537$ lbs. M. E. P., from which 14.7 must be taken, as engine is non-condensing, and $78.537-14.7=63.837$ lbs. is the most that can be obtained by that pressure cut-off at .31, but looking over into column No. 5 of same table at .31, under heading "K," we find .67301, and, instead of all the figures quoted here, multiply 116.7 by .67301 and you will get 78.537 first time (see next paragraph).

Column No. 5 is a multiplier to be used for any pressure, high or low, for the point of cut-off on same line, and the result will be at one operation the absolute mean pressure in lbs. per square inch for *that* pressure at *that* point of cut off as 165 lbs. of steam at $.01=165\times.05605=92.482$ lbs., or 34.5 lbs. cut-off at $.72=34.5\times.95689=33.02$ lbs., from which is to be subtracted 14.7 lbs. if engines are *non-condensing* in all cases. This result is the *most* energy that *that* pressure of steam, cut off at *that* point, can exert, as stated in previous paragraph, on column 3; the letter "K" used as denoting Constant, and is computed for each one-hundredth of the stroke. Multiply any absolute pressure by the "K" for the point of cut-off you assume in computation, or find on the diagram under consideration, and the result at one operation is absolute mean pressure; persons familiar with the use of logarithms will simply add the log. of "K" to the log. of the pressure used, if engine is condensing; the comparison of the planimeter area of a diagram with the result as above, will at once give the attained efficiency in percentage, while if the non-condensing is used, subtract from the result by table "K," the 14.7, and then figure on loss from theoretical, suppose we have 92 lbs. per gauge, cutting off at .41 then 92+14.7×.7757 =82.968 lbs. mean exerted pressure, if condensing, or 68.008 lbs. if non-condensing, what we should have theoretically; but the release and compression are measured by planimeter and the diagram shows only 62.41 lbs and 68.008—62.41=5.598 lbs. lost, and 5.598×100÷62.41=89.698% of the theoretical, or 10.302% of lost area or mean pressure.

This table is extremely well adapted to computing mean pressures for compound cylinders, high, low, intermediate, etc., by finding the greatest amount of mean effective pressure and assuming loss by the values on some similar engine; proportions can be made in an hour or two, instead of a day or two, in locomotive engines, the factor being obtained from some machine by actual card, it simplifies, and on condenser work it is simply invaluable, if much is to be done.

CLEARANCE

should in all cases be included in the portion of the stroke covered by cut-off before the ratio of expansion is determined, or the real ratio of expansion is the only one to be used, and that includes clearance, and to obtain the actual ratio of expansion, we have only to remember the rule, that the stroke of the engine in inches, plus clearance in inches or fractions of an inch, equals "L′," and the distance steam is carried, plus clearance, equals "l′"; to obtain the ratio then, "L′"÷"l′"=actual ratio of expansion; or, divide the total length of the stroke in inches, plus clearance in inches (or fractions), by the distance steam was carried in the cylinder, plus the clearance; then by reference to the tables find the nearest hundredth at which cut-off took place; if it is a fraction or thousandth, look over into the table of multipliers for each thousandth of the stroke, where the multiplier K is given for each one-thousandth of the stroke, and proceed as before.

ECONOMY OF EXPANSION,

or the gain of working the steam by expansion, is quickly computed by the table; "K" is always a decimal fraction, and "r" has always a whole number in it and usually a decimal as well. Proceed as follows: What is the gain in cutting off at .64 of the stroke; then "K" times "r"=gain and .92545×1.563=1.446+, or the steam does 1.446 times the work it would if the same amount of steam had been used and carried full stroke at the same pressure.

HEAT UNITS IN WATER FROM 32° TO 212° F.

(For Tables see pages 23 to 26.)

HEAT, REGNAULT'S; WEIGHT, RANKINE'S. COMPUTED BY THE AUTHOR.

Col. one is the temperature of the feed-water. Col. two, heat units in the water at t°F. Col. three is weight in pounds avoirdupois of one cubic foot of water at t°F., col. one. Col. four, Vega's log. of col. three. Col. five is the weight of one U. S. Standard gallon of 231 cubic inches, in pounds, at t°F in col. one. Col. six is Vega's log. of col. five. Col. seven is the cubic inches of water in one pound at t°F. of col. one. Col. eight is Vega's log. of col. seven. (Read across the page in all cases.)

This table has been entirely recomputed by the author from Regnault's data as related in his "Experiences" as to the "Heat Units," and the heat in col. two is the amount of heat units abandoned by the descent of the water in temperature from t°F. in the first col. to 0°C or 32° F.

In the table of "Heat of Steam" (see pages 39 to 45), "h" in the fifth col. of that table is exactly the same as the "Heat Units" in col. two of this table, with the difference that in this table the degrees F. start at 32 and stop at 212, while in the other they start at 104, or at the temperature of about one pound of steam, and run to the extent of Regnault's observations; and if in any computations it is required to obtain the heat of water above 212° F., it will be found in that table, "Heat of Steam." In the use of this table for the computation for the "Factors of Evaporation," should it in any case be required, the two tables, "Heat of Steam" and the "Heat Units in Water," will give all the information. And, for particular instructions as to the method, please refer to the reading matter under this table further on, in which full directions are given.

Tables of the "Factors of Evaporation" will be found on pages 27 to 38 inclusive; for each degree F., the equivalent of "from and at 212° F.," or on the supposition that the water is fed into the boiler at 212° F., and made into steam at 212° F., or at atmospheric pressure.

Different writers have put down various divisors for the computation for the factor of evaporation. Regnault says 536.5° C., with no chance for further argument, and the author has adopted the equivalent, which is 965.7° F., as absolutely correct from Regnault's record.

The weight of water per cubic foot is computed from Prof. Rankine's formula, and at 212° F. the weight of one cubic foot, as given in the table, is known to be about 1÷300 in excess of the fact, which difference may safely be neglected. From 130° F. to 32° F. the weight of one cubic foot given in this table has very little, indeed, if any, difference from the abstract fact, as is known; above 212° or 213° F. no one knows anything definitely as to its weight. The weight of the U. S. standard gallon of 231 cubic inches is also given for each degree; this can be readily translated into the British Imperial gallon of 277.274 cubic inches log. 2.44291 by multiplying the weight in col. 5 by 1.2003 log. 0.07930; the British Imperial gallon is supposed to weigh at 62° F. precisely ten pounds; this is not absolute, for at 62° F. it requires 277.123 cubic inches of water to weigh precisely 10 pounds avoirdupois, or 70,000 grains, the difference is immaterial unless in the computation of very large quantities; at 39.1° F. the British Imperial gallon weighs 10.0168 pounds (log. is 1.00073) and a cubic foot at that temperature has 6.2321 (log. 0.79463) Imperial gallons in it.

The seventh col. of the table has grown out of the author's note-book from measuring irregular and non-accessible tanks and other places, in order to get at their capacity in gallons or pounds, as well as measuring the clearances of engines which were difficult, but where exactness was required, and, so far as his knowledge goes, there is no table to-day in print with the same data in condensed or correct form. In measuring clearance, fill with water, taking the temperature when it is drawn off in degrees F. and weigh the water carefully in pounds avoirdupois, then multiply the cubic inches of water in one pound, in col. seven at the temperature, by the pounds and decimals of a pound, if any, and the result will be cubic inches of space (clearance), 6.5 pounds of water at 92° F.$=27.821\times6.5=180.837$ cubic inches of clearance.

The weight of one cubic inch of water is the weight of one cubic foot divided by 1728, or the reciprocal[*] of the cubic inches in one pound, or one divided by the cubic inches in one pound.

The pressure of one inch of water in depth, is the weight of one cubic inch of water at any temperature; the pressure of one foot of water per square inch is the weight of one cubic foot divided by 144.

The number of inches of water in height, or the depth of a column of water at any temperature to equal one pound per square inch pressure, is the cubic inches in one pound. (Col. 7 of the table, pages 23 to 26.)

The height of a column of water for any pressure, or the pressure for any height, is readily calculated by using column 7, reducing the feet and multiplying or dividing, as may be required.

The weight of a cubic inch of water at 133° F.$=1\div28.0931=.035595$ lbs. or $61.509\div1728=.035595$ of one pound.

The pressure of a foot of water on a square inch will be found by dividing the weight of one cubic foot by 144; as $61.509\times144=.42715$ pounds per square inch, it is also the weight of a column of water one inch square and 12 inches high at 133° F.

---

[*] **The reciprocal of any number is one, divided by the number, and the result of multiplying any number by its reciprocal, or *vice versa*, is ONE.**

The weight of one cubic inch of water .035595×12=.42715 lbs. per square inch=the weight of a column of water one foot high and one inch square, at 133° F.

The correctness of pressure gauges upon pumping engines can be readily found by this table; suppose the pressure gauge indicates 84 lbs. on the square inch and the water is 72° F., then it requires a column of water 27.7377 inches in height to weigh one pound, and 27.7377 inches =2.31147 feet × 84=194 16 feet and if the height is known to be different then the inaccuracy is at once shown.

The height of the column which is raised by the pumping engines is reported at 216 feet 4 inches, and the pressure gauge at the pumping engines shows 95. pounds per square inch, the water being 58° F. (See page 23)=27.7015 cubic inches in a pound, or 2.30846 feet in height and 216 feet 4. inches=216.334 feet ÷ 2.30846=93.713 feet of head; and the pressure gauge is wrong by that amount. 95–93.713=1.287 pounds of error.

COMPUTING THE FACTOR OF EVAPORATION FROM THE SAME TABLE.

In the use of the table "Heat Units in Water," for evaporation factor, care must be taken in remembering that the heat in water is not the temperature of the first column, but of the second column. *The heat units in the second column* must always be used in figuring for evaporation.

If the thermometer shows 50° F. for the feed-water, take the second column, reading in computation, as 18.003 heat units in a pound of water at 50° F., turn to table "Heat of Steam," pages 39 to 44, and take the H. at pressure of steam, from which subtract "Heat Units in the Feed-Water," and divide by 965.7; thus, feed-water 50° F., and steam at 105 pounds by the gauge, what is the factor of evaporation? 50°t of feed-water = 18.003 heat units. (See page 23). 105+14.7=119.7 pounds absolute pressure. (See page 43), fourth column, tells what the pressure is, between 340 and 341° F., find 119.000 pounds, the difference in thermal units is so slight, while at 340 H.=1185.56—18.003=1167.53÷965.7=1.2090, and on turning to page 31 and find feed-water 50° F., steam at 120 pounds, and it will be found that 1.2094 is the factor. Or, by turning to page 34, find K. as .00020 at 115, and 4×.00020=.0008, added to 50° F. and 115 pounds we find 1.2084+0008=1.2092; the slight difference will be seen to be two ten-thousandths of one.

THE VOLUME OF ONE POUND OF WATER.

At 39.1° F., the point of greatest density, one cubic foot of water weighs 62.425 pounds (log. 1.79536). The volume of one pound is the reciprocal of 62.425, or 1÷62.425, to use the log. 1.79536, gives 8.20464—10, or the volume of one pound of water at 39° F. is .016019 of a cubic foot.

Quite a number of formulæ are given by various writers to compute the volume of a pound of water from the absolute temperature. None of these are so nearly correct as Rankine's, which is as follows: The absolute temperature divided by 500,+500 divided by the absolute temperature (the result), multiplied by .0080095 (log. 7.90361—10)= the volume of one pound in fractions of a cubic foot; and the temperature in the left-hand column, "Heat Units in Water," page 23; to this add 461.2, then carry on the computation as above; but, to save the trouble of all this computation, take the reciprocal of the weight in a cubic foot as advised, which can be done in a moment by the use of a table of logs., and it will give the value of a pound of water at any temperature within one, or two-thousandths of one, or so nearly so as to make no practical difference.

To compute the volume of a pound of water at 200° F., proceed as follows: (200+461.2=661.2÷500=1.3324) + (500÷661.2=.7562) 1.3324+.7562=2.0886×.0080095=.016649, which is the volume of one pound as a fraction of one cubic foot at the temperature of 200° F.; the reciprocal of this amount is 60.065, which is the number of pounds that a cubic foot of water weighs at 200° F. By reference to page 26 of the table, the weight of one cubic foot at 200° F. will be found to be 60.071, a difference of six one-thousandths of one pound. The weight in the table is correct nearer than the weight by the formula, but the computations of the table are more difficult than that of the formula, but the computation by the formula is far nearer correct than most practical work requires. When necessary to compute the volume required at any heat, of a large amount of water, as in a tank, the formula will be found closely precise, and by using the log. in col. 4, as before directed, it takes less than one minute to ascertain the volume of water at any temperature between 32° and 212° F.

The volume of one pound can easily be turned into gallons or cubic inches by the use of the table, or *vice versa.*

FACTORS OF EVAPORATION.

(See pages 27 to 38.)

Taking Regnault for authority, we find that it requires 965.7 British thermal units as the latent heat of evaporation of one pound of water at 212°F. The total heat of steam divided by the latent heat of evaporation of water at 212°F gives a multiplier by which the weight of water actually evaporated by each pound of fuel is to be multiplied to reduce to the equivalent evaporation of "from and at 212° F." The total heat is modified by circumstances materially, and the rule is as follows, from the table "Heat of Steam" (pages 39 to 45) take H in any pressure under col. P., or take any temperature from the first left-hand col. in F°, from H. take the heat units in the feed-water at any apparent temperature, the remainder divided by 965.7 gives the factor of evaporation or what would have happened had the water been furnished at 212° F. and evaporated at 212° F. (for temperatures less than 104 h. must be taken from the table "Heat Units in Water," pages 23 to 26) many formulæ have been given for this, but the correct one is H–h÷965.7 in using this formula it must be borne in mind that the temperature of the feed-water at 100° F. has 68.080 heat units, so that if the feed-water in any case measures 100° F. on the thermometer, 100 must not be subtracted from H., but the heat units in a pound of water above 32° F.; as in the table referred to (page 23) and this difference is not constantly 32° F. between the first and second col. The table "Factors of Evaporation," as given in this work, are divided into three sections, commencing with feed-water at 32° F. and steam of fifteen pounds or 213° F. The first section includes 15 to 75 pounds absolute, the second section commencing with 80 pounds to 130 pounds absolute, and the third section commences with 135, closes with 200 pounds absolute, every degree from 32 to 212 is given, and at the end of each section opposite the (K) in the left hand col. is given under each pressure, a constant for every pound between the left hand and the first col. to the right hand. A note at the foot of the last page of each section explains the use of the line K, so that the factor can readily be found for each pound or fraction of pressure between 15 and 200 pounds absolute. With feed-water from 32 to 212° F. in the table (pages 27 to 38), and these factors are correct and are reliable as matters of reference. In the economy of feed-water heating which follows this article many questions will be answered. To obtain the exact factor of evaporation at any point; "we have steam at 90 pounds absolute, the feed-water is 132° F." (page 84), 90 pounds absolute=320.042° F. (page 43), H=1179.54 feed-water (page 24)=132° F. the heat units are 100.202 or (h); then 1179.54–100.202=1079.338÷965.7=1.1177 which is the equivalent of evaporation. (Page 33) feed-water at 132° F., steam at 90 pounds absolute, we find the factor of evaporation is 1.1177.

MOISTURE IN STEAM.

The amount of moisture, or water in steam, has a material effect on the value of the factor of evaporation, which is very rarely touched upon in text-books or works on the steam engine, and where the quantity of moisture in the steam is known from calorimetric test the computation of the factor equivalent of evaporation is different from the above and has often a very important effect where efficiency and economy is concerned. It may seem rather a curious fact that the consequence of moisture in steam requires less heat to dispose of a certain quantity of water, but such is the fact and the amount of this is, the percentage of water does away with an equivalent percentage of latent heat of evaporation, the more water in the steam the lower the factor of evaporation is. This simple element would frequently make large differences in "high duty plants." For example, take 90 pounds absolute, feed-water at 100, 10% moisture, in this case we must take the sensible temperature which is 320° F+ from which subtract the sensible heat of the feed-water, to this add the percentage of latent heat realized which is 90. and divide this amount by 965.7, worked out this becomes 320–100=220 (page 43) L for 320° F=888.48×.9=799.6 and 220+799.6=1019.6÷965.7=1.0558 as the factor of evaporation with 10% of moisture present in the steam (refer to page 32) feed-water 100° F., steam 90 lbs. per sq. inch, the factor is 1.1509, which is quite a difference, the same rule is applicable to any amount of water or any pressure of steam. Rule ....From the sensible temperature of the steam at pressure (see pages 84 and 85) take the sensible temperature in degrees of the feed-water, to which add the percentage of steam from which the percentage of water has been taken : in the above case 90% or .9 multiply the latent heat of steam at the pressure by this percentage and add the result to the temperature of the steam, then divide by 965.7, the result is the factor of evaporation, moisture in the steam included, it is impossible to make a table to contain the last factor, as to moisture in the steam there is from 1% to 30%.

THE ECONOMY OF FEED-WATER HEATING.

The temperature at which feed-water enters the boiler is one of the most vital of all, relative to steam power, and one of the most generally neglected; with the tables in this volume it is not a difficult matter to correctly compute the saving at any temperature, to any temperature; or as between the percentage of saving from one to another degree in the feed-water. The difference between feeding at 70° F. and 210° F. to 125 pounds absolute, or 110 steam gauge, is found by dividing one factor of evaporation in the table by the other, 70° F. to 125 pounds absolute or 344° F. (see page 31) is 1.1896, 210° F. (page 34)=1.0438÷1.1896=.87747, which, subtracted from 100=12.253% saved, taking the water from the source of supply at 70° F. putting it through the feed-water heater into the boiler at 210° F.; and this computation can be made for any range of increase, as from the hot well, or condenser, through the heater or otherwise.

Taking another example, 60° feed-water and 208° F. to pass through the heater to the steam pressure of 125 pounds absolute or 344° F. the percentage of saving is 12.841—the above answers the most usual requirements.

In order to ascertain the saving at any one point, or perhaps we might say the loss, a different method of computation is used; let us take 125 pounds absolute pressure or 344° F. and ascertain the loss by feeding at 60° F. as compared with 208° F., the temperature of the steam is 344° F.; if the feed-water is 60° F. we have to raise the water from 60° F. to 344° F=284° F. (see "Heat of Steam," page 43 and 44) "H" is 1186.80 and 284÷1186.80=23.93% of heat lost;—"*rule;* take the temperature of the feed-water from the temperature of the steam at the given pressure, the remainder is the number of degrees of heat the water has to be raised for steam at that pressure, and the total heat of steam at that pressure (H)÷ the number of degrees the feed-water has to be raised, gives the percentage of loss of heat.

For another example, feed the water at 208° F. and 125 pounds absolute, 344–208=136÷1186.80=11.459 as the percentage of heat wasted in feeding water at 208° F. into the boiler, which is under a pressure of 125 pounds absolute, and temperature of the steam is 344+°F., taking the first example as worked out by reciprocals the saving is 11.459%, feeding into the heater at 70° F. and through the heater into the boiler at 210° F.; by the second method we find that feeding water at 60° F. wastes 23.93% of the heat, while feeding at 208° F. wastes 11.459% and 23.93—'11.459=12.471 to show the connection with the previous example; taking the feed-water at 60° F. and raising the heat 284° F. the loss is 23.93%; taking the feed-water at 80° F. and raising it 264° F. the percentage of loss is 22.244; taking the feed-water at 120 and raising it 224° the percentage of loss is 18.874; at 190° F. the raise is 154° and the loss is 12.976%; at 208° the raise is 136°; the percentage of loss is 11.459.

HEAT OF STEAM.

(*See pages 39 to 45.*)

In the table given, the results of Prof. Regnault below 40° C. are omitted, but from 40° C. to 230° C. or 104° F. to 446° F. they are given exactly as Regnault recorded them, and all are figured from 32° F. to save the perplexity of adding and subtracting so frequently called for by various tables.

The (+) points are precise equivalents of the C° of the original records, and are checked in every instance. H is the total number of British thermal units in one pound of steam, at pressure per square inch of col. P, or temperature in F° of left-hand col. L. is in B. T. U. the latent heat of evaporation, required for one pound of steam from water (or heat of vaporization). P is pounds pressure per square inch (absolute) and (h) is the heat units in one pound of water at P, or temperature of feed-water col. 1, h. in the table commences at 104° F. and is the same as col. 2 in "Heat Units in Water," pages 23 to 26, to which reference will be had if a lower temperature is wanted than 104° F.; from 432 to 446 the P is omitted ; some doubt existed in Regnault's mind, and for that reason the author has left it out.

If the fact that L+h does not equal H is noted, let it be said the author does not attempt to do what Regnault *did not.* .

Columns H. L. h. are Regnault's. P is the reduction of Regnault's figures from Paris observatory to sea level and 45° Lat. by the author. The table can safely be used as reference.

STEAM TABLE FOR EACH F°

(See pages 46 to 52.)

The temperature of the steam for each F° is given in the first column. The second column is the inches of mercury at the equator, or no latitude at the level of the sea, the mercury at its point of greatest density, 32° F. The third column is Vega's logs. of column two. The fourth column is the inches of mercury at the latitude of 45° at the level of the sea, and the mercury at 32° as before. Column five is Vega's logs. of column four. Column six is the pounds per square inch of pressure of the vapor of water at the temperature in column one at 45° latitude at the sea level and the mercury at the temperature of 32° F., its greatest density. This column is what Regnault, Rankine and Dixon all refer to as the practical standard, and from this column the precise length of a pound of pressure of mercury per square inch can be computed, knowing the factor of expansion or dilation of mercury, for any latitude and elevation above the sea.

The mercury column is worthless unless its height above the sea level, the exact latitude of the place, and the temperature at which it is laid out, are all included in the computation and put upon the record ; and when this has been done, a steam gauge or indicator spring, properly tested by that column, in that place, becomes correct at any latitude or longitude of the earth's surface. But unless that mercury column has been carefully computed and accurately laid out, its observations then corrected for the changes of temperature in the mercury for each and every operation, it is entirely worthless and utterly unreliable. This table gives one an opportunity to compute from the equator or from 45°, and to check the operations wherever such are needed ; it gives pressure with exceeding accuracy, and in many instances, where high duty tests are concerned, a standard thermometer used as a steam gauge in a paraffine oil tube in the main steam pipe, or in the same way in the condenser, are far more accurate than any steam gauge the writer has yet tested. And if the temperature of the vacuum should be required in any of these computations, it will be found on page 71, column two, reading upwards, commencing at 14.7, absolute pressure, in column one, or in steam-gauge pressure, column two, the temperature is found from .7 of a pound to 13.7 pounds. Parties who require accurate data in testing, and who have never followed this method, will be surprised at being able to check their results. The steam table on pages 46 to 52 is original with the author so far as its arrangement goes, and by knowing the factor of the expansion of mercury, it is sufficiently accurate to compute a mercury column in inches, or in pounds, by using any of the well-known formulæ which embodies both quantities, but is not given here.

TABLES OF HYPERBOLIC LOGARITHMS TO FIVE PLACES.

(*See pp. 53 to 66.*)

The usual tables of hyperbolic logs. are not only exceedingly incomplete, but are, in many cases, incorrect, the table given in pp. 53 to 66, is entirely computed from Vassal by the author.

This table has a range of from *one and one-hundredth*, up to thirty, by *hundredths of one*, and while the table is extended materially over most of those in recent works, it has been done for two reasons. If our late experiences in test work are of any value, we have to carry three, four or usually five (decimal) places, to our results in order to compute final quantities, and the usual tables, running up to eight or nine, are of no use on our new triple or quadruple expansion engines, where from twenty-two to twenty-six expansions are the rule, and the writer had to stop all else frequently and compute the hyperbolic log. for 21.342, or some other ratio, by the old rule of the common log. of any number multiplied by 2.302581 += the hyperbolic log., or the *log. of the log. of any number*, + *the log. 0.3622157* = the hyperbolic log., usually denoted by the Greek short ε thus (ε). But there is another reason why the table had been extended to five places and the long ratio of expansion.

There are so many men who think a 3 or 4-place log. is all that is necessary, and from their very familiarity they consider that everybody should be equally so, forgetting that all persons who use such tables cannot interpolate (mentally), and drop or add a unit to the last figure, with any degree of correctness; for such as these the author or his book has neither use or advantage. If any man who is a receptive student, and retentive of his reading, has been over Rankine's different books, in each of which he makes use of some portions of another, and in his various computations made by four-place logs., he has frequently given his results from the very same formulæ with slight differences, and no man does or has lived who was more careful or thorough in his computations, and he also speaks of such a result as "approximate," "closely approximate," etc.

The author considers a five-place log. as the smallest number to be considered for "closely approximate" computation, and with Vega's or Bruhn's seven-place tables in hand (Bruhn's preferred, on account of the larger figures and clearer page) it is easy to read five places closely and quickly, and with just ten times the resource, hence five places are adopted in hyperbolic and common logs., a beginner in logarithmic computation had far better take a seven-place table, the two named are the very best to be had (never touch a six-place table) and progress to smaller number of places by experience.

The old tables are frequently at jumps of .05 in ratio, and frequently only two places decimal; this *might* have done thirty years ago, with 30 or 35 pounds of steam cut-off at six or seven-tenths of the stroke, but is of extremely little use or advantage with our compound ratios of expansion running from 9 to 26 or 28 and with initial pressures all the way from 140 to 225 lbs. per square inch absolute.

Any ratio of expansion up to 30 can be found instantly by direct reference to the table. Should any higher ratio be desired, the following will be easy for any one: Supposing you want a ratio of expansion of 35, then the hyperbolic log. of 3.5 + the hyperbolic log. of 10. gives the hyperbolic log. of 35, and we have log. $3.5=1.25276$ and log. $\varepsilon=2.30259+1.25276=3.55535$, which is the log. ε of 35. Any log. ε in the table can be increased 10., 100., 1,000. or 10,000. times by adding to the log. ε given in the tables; the log. ε of $10.=2.30259$, log. ε of $100.=4.60518$, log. ε of $1000.=6.90777$, log. ε of $10000.=9.21034$. The addition of a log. ε to another log. ε multiplies it; the subtraction of a log. ε from another log. ε divides it, and in this way any possible ratio of expansion can be quickly and correctly found by the use of the four numbers here given, log. ε or (ϵ) either one denote the hyperbolic log. (so-called) is to be used.

As many men who have not had educational advantages frequently ask, what has a hyperbolic log. to do with a steam-engine diagram, a short explanation is added. In any engine where the valve closes before the end of the stroke, and so prevents more steam from entering, that portion of the stroke which is made after the valve closes, is made by expansion, and the line of pressure, if put on an indicator card, at a given scale to the length of the stroke, will describe a hyperbolic curve, or a curve which is in form some portion of a hyperbola. The work done by the initial entrance of the steam, or before the valve closes, is represented in all computations by 1. in the much-used formulæ where we say, "The hyperbolic log. of the ratio of expansion plus 1.," in order to get the ratio of expansion, we must know the portion of the stroke at which the *valve* closed, or where it cut-off; then divide the whole stroke by the proportion of the stroke steam was carried, and the result is the ratio of expansion:—or before cut-off 1., after cut-off the hyperbolic log. of "r"—is the proportion of work done *during* expansion, and if steam is cut off at three-tenths .3 of the stroke, we have 1.÷.3=3.334, which is the ratio of expansion, and the log. ε of 3.334 is 1.204, and, to get at it precisely, the work done by the steam to the point of cut-off is equal to 1. and that during expansion is equal to 1.204, or more than the initial, and if the area of the diagram was measured to the point of cut-off as one quantity, and the expansion line for the rest, always remembering we go to the vacuum line, in this computation, for the other, we shall find the *first portion is* 1. and *the second will be 1.204 times as much,* and the two numbers added together show the amount of work done by *that* pressure of steam, cut off at *that* point of the stroke, expanded *that* number of times, as compared with the same amount of steam worked with no cut-off or expansion.

The ratio of the log. ε varies for *each variation of the point of cut-off,* and in this particular connection the log. from the table *is used as a number* and *not as a log. in computation,* or, to put it differently, the multiplier for the ratio of expansion consists of a number which is made up of two elements; in this case ratio of expansion is 3.334, the log. is 1.204, to which we add 1.; now we have 2.204, and if we want the mean pressure of 100 lbs. cut-off at .3 of the stroke, we say 100×2.204=220.4÷3.334=66.120 lbs. as *absolute mean pressure,* or look in the table of "Cut-off ratio of expansion," etc., in line .30 we find .66120 as the multiplier for *any* initial pressure at .30 cut-off, and this means we get, as explained above, 1. for initial and 1.204 for expansive work of the steam; study clearance as connected with cut-off ratios.

CLEARANCE INCLUDED, AS CHANGING RATIO OF EXPANSION.

Clearance in cubic inches ÷ area of piston × the stroke in inches = clearance in fractions of the stroke. 26″, cylinder 60″, stroke 286 cubic clearance = 286÷530.93×60=.008978, or less than one per cent.

Clearance in cubic inches ÷ area of piston = clearance in cubic inches × stroke in inches, either formulæ, = the equivalent of the cylinder in inches or fractions of an inch; 286÷530.93=.53868 (or .008978×60=.53868), equal to .53868 inches in length added to the stroke on the diagram, to compute actual ratio of expansion, or the percentage of clearances, .008978×60=.538680 inches added to the stroke, or cubic inches of clearance equal a trifle over one-half of an inch added to the stroke.

To find actual ratio, suppose the diagram showed a cut-off at ¼ stroke equals 15 inches, the ratio (apparent) is from .25, and would be 4., and log. ε+1.=2.386 K =.59650, and with 100 lbs. it would give 59.650 lbs. absolute M. E. P. To correct this for clearance, length of stroke = L, length of cut-off in inches = l, and clearance = c; then L + c = L′, and l + c = l′; and to get corrected clearance we say: L′ ÷ l′, or the length of stroke + clearance in inches of stroke, divided by the length at which steam was cut off, + clearance in inches of stroke; then 60.539÷15.539=3.896 as R′ or the *corrected ratio;* the former R = 4., as above, 3.896 less, between .25 and .26 of cut-off in "cut-off ratio of expansion," or about .1 above .25, and by looking in table of multipliers of one-thousandths of the stroke, we find .59789 as multiplier, or 59.789 lbs. M. E. P. as correct results.

Taking a case from actual practice, piston 10″ diameter, 10″ stroke clearance = 291. cubic inches, cut off at 3.21″; then 10.÷ 3.21 = ratio of expansion 3.1152, or between .31 and .32 of the stroke. Volume of the cylinder 785.4 cubic inches, and 291÷78.54=3.705 inches of clearance to be added to stroke, 291.÷ 78.54×10.=37.05 per cent. clearance in the engine, as above, and to find the actual rate of expansion, *clearance included,* L′=10″+3.705″ or 13.705″ and l′=3.21+3.705=6.925″, and 13.705÷6.925=1.9791 R′, or actual ratio of expansion, or between .50 and .51 of the stroke, nearer .51 +. These engines *were* running the electric light plant in one of the finest buildings in New York City.

$$\frac{1.}{\dfrac{\dfrac{1}{r}+c}{1+c}}$$

Rankine gives a rule by which R′ can be computed by a little care as follows, and to apply the figures of the last engine to this formula, apparent: "R"=3.1152, "c"=.37; then divide 1. by 3.1152,=.32106; add the "c"=.37, and we have .69106, and dividing .69106+1.37 (or 1.+"c") and we have .50443, and 1.÷.50443=1.982 as the actual ratio or "R"′. To aid those unused to formulæ it is repeated, with the factors of this problem. Any other similar problems are with ease computed, especially with table of logs.

$$\frac{1}{\dfrac{\dfrac{1}{3.1152}+.37}{1.+.37}} \quad \text{or} \quad \frac{1.}{3.1152}$$

and add (c.) .37; then that result is divided by 1.+.37=.50443, and 1.÷.50443=1.982, given as 1.9791 above, as R′ or actual ratio of expansion.

ENGINE CONSTANTS.

COMPUTED ENTIRELY BY THE AUTHOR.

(*See Pages 67 to 70 for the Table.*)

Col. one is the diameter of the piston or cylinder in inches by quarters of an inch, from 6 to 37, then by half inches to 61, and then by inches to 117 inches in diameter. Col. two is the area of piston or cylinder in square inches entirely computed. Col. three is Vega's log. of the area. Col. four is the constant for one pound of mean pressure per square inch for the piston running at the speed of one foot per minute, or for each foot of its motion. Col. five is the constant for one pound of mean pressure per square inch, for the piston running one hundred feet per minute, or for each one hundred feet of motion of the piston. Col. six is the constant for one pound of mean pressure per square inch for the piston running one thousand feet per minute, or for each one thousand feet of motion of the piston. Col. seven is the log. of col. six, and by changing the characteristic it can readily be made use of for cols. four and five as well as col. six. Col. four is one of the most important factors in the proportioning of compound-engine cylinders that the author has ever found, and it is inserted in this place more for that purpose than for the obtaining of horse-power from indicator diagrams; but it is frequently useful in other ways.

The areas in this table are intended to be reliable, and the real purpose of the table is to make it easy to compute constants for each or any engine cylinder with which the engineer may have to do. The constants are based upon the usual formula of "The area × by the speed of the piston in feet ÷ 33000," the amounts in cols. five and six being the exact amounts of horse-power on the piston of the diameter of col. one running either at one hundred or one thousand feet per minute for every pound of mean pressure exerted.

To ascertain the horse-power of an indicator diagram, after the mean pressure is computed, it is only necessary to multiply the mean pressure of the diagram by the constant for the number of feet that the piston makes, on the data given by the indicator diagram. If we have a 10×10 inch engine, running 375 revolutions per minute, and the diagram shows a mean pressure of 72.31 pounds, 375 revolutions × 20 inches for each revolution ÷ 12 inches, to reduce it to feet, gives 625 feet of piston speed per minute, and the constant for 10 inches diameter is .238 of a horse-power for each one hundred feet, and as we have 6.25 hundred feet, .238×6.25=1.4758 horse power for each pound of mean pressure on that engine at a speed of 625 feet per minute, and this constant remains good for that engine at that speed; 1.4875 horse-power × 72.31 pounds gives 107.56 + horse-power as the result.

Taking col. six, if any engine constant is to be multiplied by the feet of speed of the piston as a decimal, if the speed is less than one thousand feet per minute, taking the 10×10, at 625 feet per minute, to get the constant for that speed on that engine, 10-inch in diameter at a speed of one thousand feet per minute, gives 2.38 horse-power for each pound of mean pressure, and is the constant when that engine runs 625 feet per minute; 2.38×.625=1.4875 horse-power for each pound of mean pressure, and this, multiplied by the pounds of mean pressure upon any diagram from that engine at that speed, gives the horse-power. Taking a 26×60, running at 62.4 revolutions per minute, 62.4×10=624 feet of piston speed per minute; 26 inches at one thousand feet=16.089 horse-power for each pound of mean pressure, and 16.089×.624=10.039 horse-power for one pound of mean pressure on that engine at that speed. And suppose that the speed of that engine changes somewhat, running only 61.6 revolutions, and you require to know how much difference it will make in the power: 61.6×10=616 feet per minute, and 16.089×.616=9.9109 horse-power for each pound of mean pressure.

Any engineer who keeps track of the different speeds of his engine can also keep the record of the different constants, and will not need to compute them but once for the same speeds.

TABLES OF PRESSURE, TEMPERATURE, VOLUME AND DENSITY OF DRY SATURATED STEAM.

This table will be found different from any table which has been printed up to this time, but if reference is had to "Miscellaneous Scientific Papers," oftener spoken of as the "Memorial Volume," which was published after Prof. Rankine's death, or to the mass of his contributions to the "Engineer," and to the various "Royal Society Proceedings," and "Philosophical Transactions," the abstract facts with reference to the volume and density of steam, both from Rankine's theory and his working out Regnault's results, will be found. It is strictly upon Regnault's experiments that the density of steam in this table is computed; it is from Rankine's basis of "Dry Saturated Steam," which, at atmospheric pressure, gives 26.36 cubic feet in one pound avoirdupois.

Different starting points have been made use of by different authors, and in some instances the "Thermo-Dynamic" computations have been followed, and this system is usually applied for the purpose of bringing the density, or the volume, to the exact curve when graphically expressed. Regnault, in his most accurate experiments, has most distinctly stated the fact that the results of the observations of his experiments "*do not follow* *a curve*, but vary somewhat from it, running above and below, rarely touching the curve exactly;" hence the "Thermo-Dynamic" computation cannot be correct if Regnault's is. The writer has made careful investigation into everything relating to this, and has decided on following Regnault as the most reliable authority, as there is no doubt of the precision of his observations from actual experiments.

Taking Prof. Rankine's exceedingly careful investigations of Regnault's data, and Rankine's verification of Regnault's work, and it would seem that anything much at variance with the results of one, and the confirmation of those results by the other, must be without a groundwork of fact.

This is particularly noticeable in some of the comparisons made, showing the variation or deviation of Rankine's tabulated results, with the results of other methods of computation ; while Rankine's work shows that he used three or four-place logs., while the results of the comparison were made from the use of seven and ten-place logs., but the critical writers *did not explain this difference.*

Taking all possible data, the fact remains that Regnault and Rankine practically agree upon the density or "weight of the vapor of water," and this table is computed upon that basis, from Rankine's formulæ connecting with Regnault's observations and results.

This is by many competent authorities to-day believed to be strictly in line with actual fact, so far as any repetition of Regnault's work has been possible, that more data has accumulated but to confirm the precision of this amount, 26.36 cubic feet to the pound, than any other amount.

Regnault's experiments were not conducted directly on the density of steam, but the data which he gave from his experiments on "The heat transferred *from the boiler to the condenser*," *by sending from the boiler to the condenser*, known weights of steam under different pressures, and it is from this data that Prof. Rankine remarks, " *That whatever may prove to be the law " connecting the density, pressure and temperature of steam under other circumstances, the densities and volumes in these tables cannot err to an extent appreciable in practice, for steam obtained under circumstances similar to those of M. " Regnault's experiments, which circumstances are in all important points similar " to those under which steam is obtained in ordinary steam engines.*"

The tables referred to are those computed by Prof. Rankine [in Manual of the Steam Engine] in 1849, published in 1855, and were perfectly corroborated by Fairbairn & Tate, whose experiments were published in 1859, and, if the reader desires and will refer to the volume of " Miscellaneous Scientific Papers," the fullest explanation will be found as to why Fairbairn & Tate's results differed from the results of the " Thermo-Dynamic Theory," and why certain discrepancies appear in those tables ; also why 26.36 cubic feet of steam at a pressure of one atmosphere for " dry saturated steam " is the correct amount.

There is certainly no authority that will compare with Regnault's observations for accuracy, and not only in corroboration of that authority, does stand, or has stood, higher, and nearer indisputable than that of the late Prof. Rankine.

Prof. Cotterill, in his "Steam Engine," which is, without the least exception, critical, compendious, and exceedingly impartial in all his deductions, has adopted in the edition of 1890 almost the identical basis that the writer has in this volume; but in the strict use of Rankine's formulæ by the author of this volume, the differences are less in this somewhat at higher pressures than with Prof. Cotterill, and it is as certainly the fact that the weight of one cubic foot of steam by direct experiment, as is known, up to 70 lbs. absolute, *is very slightly more* than the weight as computed by either Prof. Cotterill or the author of these tables. Yet, in many of the tables now used, the density is given as less and the specific volume is more cubic feet in one pound, while the fact is absolutely the reverse, so far as the actual result of reliable experiment is now known.

The tables in this volume are as nearly correct as our present knowledge of the subject will permit; every result in the table has been carefully computed from the formulæ referred to, and the author's intention is that they shall be correct.

The first column is absolute pressure.

The second column is steam-gauge pressure.

The third column is temperature nearest F. degree.

The fourth column is cubic feet in one pound or specific volume.

The fifth column is five-place logs. of column four.

The sixth column is weight of one cubic foot of steam or density in lbs.

The seventh column is logs. of column six.

The eighth column is cubic feet of steam from one cubic foot of water or relative volume.

The ninth column is logs. of column eight.

The various "heats" of steam are not connected with this table, for the reason that this is a working table, not a theoretical one, the author's design being to make it for the information of students as well;—but for computations in which total heat, latent heat and heat of steam is concerned, please refer to the tables "Heat of Steam" on p. 39, "Steam Table of F. Degrees," p. 46.

In the table of "Pressure, Density, etc.," the third column is the temperature to the nearest degree, as it is a certainty that the pressure of steam in pounds per square inch has little regard for the temperature in even degrees, the writer has adapted what he has for many years practiced, using the gauge pressure, referring to the absolute pressure for temperature, and then going to the "Steam Table of F. Degrees" for the exact pressure for that degree. In the present work the pressure and density table gives pounds for computation ; the table "Heat of Steam" gives the total heat, latent heat and heat of the water, while the "Steam Tables of Regnault's" give the precise pressure both in millimeters in mercury and pounds per square inch, each table having its own properties, each being complete, and, with a little familiarity on the part of the user, there will be no wish to refer to the ancient arrangement. The table of Pressure, Density, etc., has in it all the elements for the computation of pounds of steam or water per horse-power; for evaporation tests in connection with the other tables, and for the now *fashionable* "hypothetical test," the addition of the logs. to the various tables will be appreciated by those who have much such work to do.

Attention is called to the various uses of the terms "specific volume" and "relative volume" in the present table; specific volume is the number of cubic feet of steam in one pound, while the relative volume is the cubic feet of steam at *that* pressure which are made from one cubic foot of water. In computations for condensation of steam, and so much of the calculations which are now given with condenser, elevator pumps and a variety of new factors, this table is a whole book, and will be referred to further in general items. Each pound in the table is complete, from absolute zero or minus 14.7 to 250 lbs. absolute pressure per square inch.

REGNAULT'S RESULTS AT THE PARIS OBSERVATORY.

(*See Pages 76 to 78.*)

Col. 1 is the degrees C. Col. 2 Regnault's record of pressure in millimeters at the Paris Observatory, 48° 50′ 14″ north latitude 60 meters above the sea level. Col. 3 Vega's seven-place logs. of col. 2. Col. 4 is the pounds pressure per square inch at a latitude of 45° at the sea level, the mercury at the temperature of 32° F. Col. 5 is the log. of col. 4. Col. 6 is the degrees F. equivalent to the degrees C. in the first col.

The first two columns of this table are precisely what M. Regnault left on the record in his final report, entitled "Relations des Experiences sur Machines à Vapeur," Tome 1, printed in 1847. This was revised after the first report was printed in the "Memoirs of the Academy of Sciences." After its first publication some typographical errors and a few minor errors in the formulæ were corrected, and it is from this revision that all the author's work had been done, except some of the comparison, and the correction of several apparent typographical errors which are in Tome 1, have been corrected in the tables, but beyond that, no change has been made in any way directly or remotely. Regnault's results are, without doubt, so nearly correct that any attempt to improve them, would end in far more inaccuracy than now exists, from the fact that changes would be utterly misleading.

The processes of his work, and his peculiar methods of ascertaining and eliminating errors have elicited only the highest commendation of men who are aware of the difficulties attending such experiments, and the amount of careful labor involved in researches so extensive as those which he made.

Much comment has been passed on M. Regnault's work, much recomputation has been attempted, and various authors have advanced many suppositions. The author, after studying Regnault and roughly translating its important parts, had a carefully corrected and compiled translation made, which is shortly to be published in another volume; and from a long acquaintance has drawn only one conclusion, namely, M. Regnault's work is far better as he left it than the efforts of later authors to make improvements on it; the table has Regnault's final deductions at the close of his work upon steam, and the reduction made in that table is by the formulæ of the Rev. Robert V. Dixon, A. M., Professor in the University at Dublin, 1849, and to which Prof. Cotterill, in his "Steam Engine," refers as "having been done with the utmost precision," but Prof. Cotterill also adopts several of Prof. Dixon's tables in concise form and the formulæ as well; Regnault observed the temperature of steam and water, measured the pressure by the mercury column directly. The author has computed Regnault's observations at the Paris Observatory by Dixon's formulæ to the accepted standard of all such data, namely: 45° latitude at the sea level, and the mercury at the temperature of 32° F. or 0° C. This has been done without any suppositions, interpolations or ideas of his own, no corrections or assumptions beyond the fact as Regnault observed and Dixon translated it from C° to F°, and inches of mercury, for the precise degree F. The pressure per square inch in this table is given in pounds and fractions for each C° and the last column on the page shows the equivalent in F° so that it is readily referable. A slight difference will be found between this table of Regnault's results at the Observatory and the table of each degree F.; computations in this table were made with seven-place logs., in the table for the degrees F. only three-place decimals were used in the original. For all practical purposes there is no difference between the two, yet the little variation may cause inquiry, for that reason alone it is noticed here.

The table of each F° gives pressure on pounds per square inch for the exact degree F., and that table and this one refer to each other in that particular. The last table in this book gives temperature of the steam for each pound of absolute pressure, and the table of pressure temperature, volume and density, on pages 71 to 75, gives the temperature for each exact pound absolute from 1 to 250. By referring from one table to the other, the degrees temperature for pressure, or the exact pressure for any degree of temperature can be found either as reference or for computation.

Regnault's recorded results are seen in pressure of millimeters of mercury, and degrees C. The reduction of his results have been in conformity with a recognized standard which involved all the factors properly applied.

Height above the sea, expansion of mercury, change of the cosine of λ in its relation to g, in order to make the reduction simple and accurate, it is believed that an error does not exist which is appreciable. In the original record Regnault experimented and observed all the facts to —32° C.; that portion of his work is of no value whatever here, and has therefore been omitted from the tables.

MEAN PRESSURE MULTIPLIERS FOR EACH ONE-THOUSANDTH OF THE STROKE.

(See Pages 80 to 81.)

The numbers in second column of this table are precisely those in column 5, heading "K" in cut-off, ratio of expansion, etc., on page 21, it is frequently required in computations of compound engines to get at a certain mean pressure with a given back pressure, with this table it can be done with a vast saving of time, in desiring to know at what point on an engine it is necessary to cut off a certain pressure to get a specified mean pressure, one or two operations secures the exact result, or, if we know our initial pressure and what mean pressure is needed, the table gives it almost at a glance, in proportion of cylinders to each other, the table of temperature of steam, and this one will settle the ratios quickly.

Suppose we have 100 lbs. of steam as initial, and we wish to get 31.5 mean exerted, and release near atmospheric line–31.5+14.7=46.2 lbs. mean absolute is required and 46.2÷100=.46200, and if we look across the page at .165 we find .46185, and in next column, or .166, we find .46366, hence 100 lbs. absolute cut-off at .165 of the stroke gives 46.185 pound mean exerted pressure absolute, and 46.185–14.7=31.485 lbs. on non-condensing engine, suppose we have 80 lbs. absolute, and wish 50 lbs. mean exerted above the atmospheric line, 50+14.7=64.7 and 64.7÷80=.80880 found at .449 as .80868 and .80868×80=64.704 as the absolute mean exerted pressure of 80 lbs. cut-off at .449 of the stroke, and 64.7– 14.7=50 lbs. as wanted.

To obtain a desired mean pressure from any pressure, divide the mean pressure you want in lbs. by the initial pressure, the result is always a decimal, look up that decimal in the table, find between what two points it lies, take the nearest one and run down the decimal from top and left hand of the page, .80868 is in the ninth column of line 44, then it reads .44 at left hand and means forty-four hundredths, while the 9 over the last column is nine one thousandths, and the result is .449 four hundred forty-nine one thousandths of the stroke.

To obtain the point at which the engine did or should have cut off when diagram was taken, absolute pressure was 121.13 lbs., mean pressure was 73.24 lbs. above the line of instrument or atmospheric line, and two pounds of back pressure shown, then if the spring of indicator was correct (and *none* of them are) and if the back pressure had not been there, the exhaust would have followed the line, and we should have had two pounds more of the M. E. P., then $73.24+2=75.24+14.7=89.94$, and $89.94\div121.13=.74251$, which is found between columns 4 and 5 of line .37 and .375, is nearest.

For condensing engines the 14.7 is not added or used. If the size and piston speed of an engine is known from the table of constants, p. 67 calculate the "K" for one pound of pressure in I. H. P. and divide the I. H. P. by the "K" and the result is M. E. P. and by a very few figures from this table the point of cut-off that is the least possible to do the work, is quickly computed.

Suppose in a compound engine with 180 lbs. absolute cutting off at .46 we have a mean pressure of 126 lbs. only, including the receiver pressure, and we desire to know how much is lost in mean pressure, by the action of the valve in closing compression and all other causes in that cylinder.

Reference to either table shows us the "K" for .46 is .81742 and $180\times.81742=147.136$ lbs. as the amount we should obtain in an automatic engine, as we have only 126. lbs. then $147.136-126=21.138$ lbs. as the M. E. P. lost by all causes.

The percentage of loss is $21.136\div147.136=14.365\%$ of the theoretical mean exerted pressure lost, or $100-14.365=85.635\%$ of the theoretical utilized, or $126.\div147.136=85.635\%$ realized.

Many other uses of these numbers can be found in all the computations on Condensing, Non-condensing, Simple, Triple, or other makes, and that results are very closely approximate to absolutely correct, by one, or at most two, simple computations.

STEAM USED EXPANSIVELY.

Data from Rankine. Entirely computed by the author for each one-hundredth of the stroke; r = ratio of expansion; $1\div r$ = effective cut-off; p_m = mean absolute pressure; p_1 = initial absolute pressure; col. $1=1\div r$; col.

2 = r ; col. 3 = rpm÷p1 ; col. 4 = p1÷rpm ; col. 5 = p1÷pm ; col. 6 = pm÷p1.=K.

Col. 1 = point at which steam is cut off in hundredths of the stroke = 1 ÷r ; col. 2 = ratio of expansion with cut-off of col. 1 = r ; col. 3 = hyperbolic log. of ratio of expansion + 1 = rpm÷p1; also ratio of mean absolute pressure to terminal pressure ; also ratio of whole gross work on piston to gross work during admission ; col. 4 = ratio of gross work during admission to whole gross work = also ratio of terminal absolute pressure to mean absolute pressure and = p1÷rpm ; col. 5 = ratio of initial absolute pressure to mean absolute pressure = p1÷pm ; col. 6 = ratio mean absolute pressure to the initial absolute pressure, or the decimal in col. 6 × by any initial absolute pressure gives the mean absolute pressure for the point of cut-off in first column on same line, and is = pm÷p1, see table pp. 21 and 22, line K. The absolute pressure of release equals the initial absolute pressure ÷ by the ratio of expansion and = p1÷r, or any initial pressure divided by the number in col. 2 for that point of cut-off, or for any other point, see clearance computations, pp. 21–22.

The ratio of the mean absolute pressure to the initial absolute pressure for any possible point of cut-off, not in the tables, is found by multiplying the initial absolute pressure by the hyperbolic log. plus 1, and dividing that result by the ratio of expansion (corrected for clearance when possible, see next paragraph above) and col. 6 of "Steam Used Expansively" is the multiplier, and is equivalent to Rankine's 1+ ε r×p1÷r, or pm÷p1 mean absolute pressure ; the 1+ εr is col. 3 of both tables referred to pp. 21, 22 and pp. 82 and 83.

The relative efficiency of steam cut-off at any point is found by multiplying the ratio of expansion (col. 2) by the number under K, pp. 21, 22, or in the table "Steam Used Expansively," pp. 82, 83, thus, .3 (r=3.34) K=.66120 and 3.34×.66120=2.4808, or that the steam cut off at .3 of the stroke did nearly two and one-half times as much work during initial and expansion as it did up to the point of cut-off, or a gain of 2.4808—1= 1.4808.

The computations in table of "Steam Used Expansively" are based on moderately moist steam and the Boyle-Mariotte law of expansion of pv= constant, or hyperbolic, expansion.

It is difficult, to some extent, to cite examples from the table of "Steam Used Expansively." It is one of the most important tables in Rankine's whole work, and one of the very least understood.

The table as computed here is five times as long as that in Rankine ; Rankine's explanation of this, in the book where it was first given, consists of precisely 12 words, in one of the other books 37 words are used, while the author, in making the most concise explanation possible, has used between ten and twelve hundred words ; while five pages carefully written would not more than convey an adequate idea of its applications and value;

it is the key to the construction and proportioning of compound cylinders beyond any other work, and for the ordinary engineer who desires to get at the facts closely and with the least waste of time the following will explain some of the most used points: Taking .2 for the same cut-off at that point we have $r=5$, and the $\varepsilon+1$, as shown in col. 3, has 2.61. Here are all the elements for computing the mean pressure, taking the initial pressure at 80, it becomes $80 \times 2.61 \div 5 = 41.76$, which is the mean absolute pressure, another way referred to in the description of the "Table of Ratio of Expansion," pages 21, 22, equally applicable to this table of "Steam Used Expansively." In col. 6 we have the decimal $.52180 \times 80 = 41.76$, precisely the same as before, notice the two ways of arriving at the result. Now we would like to know what the terminal pressure is with 80 pounds cut-off at .2 of the stroke, the rule is repeated; divide the initial absolute by the ratio of expansion, so that $80. \div 5 = 16.$, for 16. pounds is the terminal pressure absolute for 80. pounds cut-off at .2 of the stroke. Col. 4 of "Steam Used Expansively" is the ratio of terminal absolute pressure to the mean absolute pressure. We have already found mean absolute pressure to be 41.76; if we multiply the mean absolute pressure by the decimal in col. 4, we shall at once have the terminal absolute pressure, but by a different method or formula; then $41.76 \times .383 = 15.994$. It will be seen there is a very slight discrepancy in the two results, it being impossible to produce precise results with three figures. Col. 5 gives the ratio of the initial to the mean pressure, and if we find $41.76 \times 1.9164 = 80.$, or if we have 80. pounds initial pressure cut-off at .2, we can ascertain what the mean pressure will be by dividing 80. by the number in col. 5, so that $80. \div 1.9164 = 41.76$. Col. 3, if multiplied by the terminal pressure, will give mean pressure; so that in this case $16. \times 2.61 = 41.746$, and in this way almost anything about an indicator diagram can be found out by the table "Steam Used Expansively," pp. 82 and 83.

The first three columns of "Steam Used Expansively" are the same as the first three columns in the table of "Ratio of Expansion Cut-Off," etc., on pp. 21, 22; the third column of the two tables will be found to very slightly disagree with each other; the two tables are calculated by entirely different formulæ, positively Rankine's, but one is for moderately moist steam and the other is for nearly dry steam, but there is no difference of any moment in practical matters, and he himself remarks that such is the case. The author has left his own notations over the columns, and they are as follows: The first left-hand column is one divided by the ratio of expansion, and gives the cut-off in hundredths of the stroke; col. 2 is the ratio of expansion of the cut off col. 1 on the same line; col. 3=mean pressure × the ratio of expansion ÷ initial pressure; this col. also equals the hyperbolic log. of the ratio of expansion +1; col. 4=the initial pressure ÷ the ratio of expansion × the mean pressure; col. 5 = the initial pressure ÷ the mean pressure; col. 6 = the mean pressure ÷ the initial pressure;

also = K, same as in table in pp. 21 and 22. In using this table, wherever the word pressure is used the absolute pressure is intended, and this must be carefully adhered to in order to obtain correct results; the relations of the columns to each other is explained in the earlier part of this article, the earlier part being intended for those who use formula, the latter part for those desiring fuller explanation; there will be no difference in the results in either case.

TEMPERATURE AT EACH POUND ABSOLUTE PRESSURE, 1 TO 350 LBS.

(See pages 84 and 85.)

The tables on pages 84 and 85 give the pressure in absolute pounds per square inch, and the corresponding temperature for the exact pounds in F. degrees. The table on pages 71 to 75 gives the same temperature for both the absolute pressure and corresponding steam-gauge pressure in F. degrees.

The other tables in this volume give the exact pressure for each F. degree and, by changing reference, all the data can be had in either way required.

Such a table of temperature of exact pounds is of little actual use, for precision of pressure is rarely found; the various tables cover the whole ground, pressure for each degree and the temperature of each pound.

Tables on pages 71 to 75 give temperature, volume and density for each pound absolute and steam gauge in parallel columns.

THE BULK OF WATER.

In computations upon water it is frequently necessary to know how much room the water will take up as well as what its weight is. By the use of the table "Heat Units in Water" (pages 23 to 26) this can very easily be ascertained by referring to that fraction of a cubic foot which one pound of water at any temperature occupies. In the preceding article Prof. Rankine's formula is given as follows: The absolute temperature in F. degrees÷500) + (500 ÷ the absolute temperature ×.0080095 (log. 7.9036054—10) at 212° this would read as follows: 212+461.2=the absolute temperature of the water, and the formula would stand 673.2÷500) + (500÷673.2×.0080095=.016731 this result is the fraction of a cubic foot which will be occupied by one pound in weight of water at the apparent temperature of 212° F., or the absolute temperature of 673.2°F.; this formula is given in full that any one wishing to familiarize themselves with the rules, in order to become independent of the tables, or to check their results may do so, but there is a vastly easier way to do this, and by the use of this particular table the result is as correct. To obtain the bulk of a pound of water at any temperature from 32°F. to 212° F. Rule—take the quantity the third column of "Heat Units in Water" and divide the unity by it, for 32°F. this will stand as follows: 1÷62.420=.0160206, which is the fraction of a cubic foot occupied by one pound of water at 32°F.; in the use of logs. this can be done far quicker; for instance, the log. of 1—the log. 1.79532=8.20468—10=.0160206 if we wish to ascertain the fraction of a cubic foot taken up by water at 70° F. 1÷62.312=.016048. Then for comparison we find that at 32° F. a pound of water occupies .0160206 of a cubic foot; at 70° F. .016048; and at 212 F. .016731. If it is wished to ascertain what the ratio between the bulk of water between any two temperatures is, divide one quantity by the other and the result is the ratio The bulk at 212° F.÷ the bulk at 32° F. shows that the same number of pounds at 212° F occupies 1.0443 times as much space as it does at 32° F., and to prove this divide the weight of water at 32° F. by the weight of water at 212° F., and the density or weight of the same number of pounds of water at 32° F. is 1.0443 times as much as at 212° F., so that to ascertain how much more room water at one temperature will occupy than at another, divide the weight at one temperature by that at the other.

THE EFFICIENCY OF BURNING COAL.

Factors of evaporation connected with heat units in coal. If the factor of evaporation is known it is comparatively easy to ascertain with what economy the coal was burned, it is necessary also to know how much water was evaporated with a pound of coal. In reading a report it was noticed that the factor of evaporation was 1.06, the feed-water was at 189° F.+on reference to the table, page 34, the absolute pressure was 100 pounds, or 85 pounds steam gauge, to ascertain the number of heat units for each pound of water raised from the temperature of feed water or steam at 100 pounds, multiply the factor of evaporation by 965.7 or reverse the process and find the factor of evaporation;—1.06 multiplied by 965.7 = 1023.62 as the number of heat units required to raise the feed-water from 189.7° F. to 100 pounds steam pressure we find that 8.35 pounds of water was evaporated by one pound of dry coal, or the correction for the water contained in the coal, multiplying the number of heat units necessary to raise one pound of feed-water to the pressure of steam 1023.62 by 8.35 gives 8547.3 as the total number of heat units given out by one pound of that coal, at that time, and under those conditions, the natural inference would be that the coal was very poor, or that the combustion was very bad. *Rule*: The factor of evaporation multiplied by 965.7 = B. T. U. used in the evaporation of the feed water from the temperature given to the absolute steam pressure given. Having ascertained this and knowing the temperature of the feed-water add to the number of heat units required to raise the feed-water to pressure, the number of heat units in feed-water of the temperature given and you will have "H" or the total heat in the steam under the stated conditions. Caution.—Do not confound the expression "Total Heat," as used here, with the "Total Heat" in the table, page 39. As used here, it means the total heat of the water from the degrees F. of feed-water, to the degrees F. of the steam at pressure it was used, or the total heat required to raise the water from feed (and that varies with different plants) to whatever the pressure it was used in engine.

THE WORK OF ONE POUND OF STEAM IN FOOT POUNDS.

The ordinary computation of the duty of steam is a complex problem, and in this instance the author introduces an empirical formula of Mr. Brownlee; this rule based upon a combination of Rankine's, and for general purposes is closely correct. The maximum amount of work which a pound of steam admitted into a cylinder or cylinders and expanded is given in foot pounds of work by the following expression:

$W = 16.95\ (p1v1 - p2v2) + v2\ (p2 - p3)$. This long formula translated means W = the work in foot pounds, 16.95 is a constant, which is used on both condensing and non-condensing engines p1 = the initial pressure absolute of steam per square inch, which is to be multiplied by the number of square inches in a foot, or 144, in every instance when used in this connection. v1 = the specific volume of the steam, or the number of cubic feet in one pound, and is to be taken from col. 4 in the table on page 71, p2 is the pressure of release, or at the end of expansion, whatever that pressure may be, this is always absolute and in this case the figures are made upon a condensing engine, whether single, double or triple does not matter, v2 = the volume of steam at p2 or the volume at the pressure released. The specific volume must be taken from col. 4 on page 71, if the formula is applied to a condensing engine which expands to a pressure of

5 pounds absolute and has a return back pressure not exceeding 2 pounds, then the rest of the formula outside of the second bracket may be omitted, and substitute for it, starting at the second bracket (+ 31445), but as condensing engines do not always expand to precisely 5 pounds, and frequently have more back pressure, the rest of the formula reads $+ v2p2 - p3$, $p2$ is the pressure at release, and $p3$ is the back pressure above the absolute vacuum line whatever these figures may be in the example that the reader will work, will be governed by the indicator diagram on which they are working; to work the example the initial pressure of steam × the volume at that pressure is the first amount, the pressure of steam at release × the volume of steam at the pressure released is the second amount, the second amount is to be taken from the first amount, and the remainder $\times 16.95$ we now have a different amount which is very much larger; starting at the plus sign (+) after the second bracket the pressure of release $\times 144 = p2 - p3$ whatever it may be $\times 144$ and the difference between these two last amounts $\times v2$ and that is to be added to the previous amount, the result being the greatest amount of work in foot pounds that one pound of steam can do under those conditions.

Example.—An engine carrying steam at 125 absolute, expands down to 5 pounds and has two pounds of back pressure in the cylinder, or lacks two pounds of coming down to the absolute vacuum line, what is the greatest amount of work in foot pounds done by one pound of steam? Worked out, $p1 = 125 \times 144 = 18000$, $v1$, col. 4, page $73 = 3.5151$, $p1 \times v1 = 63.272$, $p2 = 5$ pounds $\times 144 = 720$, $v2$, col. 4, page $71 = 72.792$, and $720 \times 72.792 = 52409$, then $63272 - 52409 = 10\,863 \times 16.95 = 184\,130$. Taking the last leg of the formula $p2 = 5 \times 144 = 720$, $p3 = 2 \times 144$ or 288, $720 - 288 = 432$ and $v2 = 72.792 \times 432 = 31\,445$, the first amount $184\,130 + 31.445 = 215\,575$ foot pounds as the maximum amount of work which can be done by 125 pounds absolute pressure of steam, expanding down to 5 pounds absolute, and having 2 pounds back pressure, to get at the ratio of expansion which is actual in this case $v2 \div v1 = 72.792 \div 3.5151 = 20.708$ which is the actual ratio of expansion. $v1 \div v2$ the fraction of the stroke at which steam was cut off, in this case $3.5151 \div 72.792 = .04829$ as the fraction of the stroke at which steam was cut off; it must be remembered the above formula *does not* apply to a non-condensing engine in the form already given.

H the total heat at $p1$, feed-water at 100° F., 125 pounds, page 43, $H = 1186.8 - 68.080$ the heat units in feed-water at 100° F., page 24, H in this particular example $= 1118.72$ is the total number of heat units required, taking the feed-water at 100° F. and evaporate it into steam at 125 pounds absolute, the feed-water may be taken at any temperature, simply subtracting from the total heat H in the table, page 39, at any pressure, the heat units in feed-water at any temperature, see table on page 23, or H as used in this formula is the total heat under certain conditions, and *is not* H in the table, page 39, from which, as before stated, that the real H of the formula is to be computed. $h =$ the quantity of heat necessary to prevent condensation during the expansion, this quantity must be computed and the amount of heat charged against the final result. To obtain h $16.95 \times p_1v_1 - p_2v_2$, which can be taken without computation from the formula above, in W drop off the last leg beyond the second bracket $\div 772 - .305 \times t_1 - t_2$ in this formula, this is $184130 \div 772 = 238.51$—the temperature of 125 pounds, page 73, 344° F.—the temperature of 5 pounds absolute, page 71, which is $162.3 = 181.7 \times .305 = 55.42$ and $238.51 - 55.42 = 183.09 = h$.

t_1 in this formula = the temperature of the steam at the absolute pressure, col. 3, page 71, or see table, page 84; $t_2 =$ the temperature at the pressure at the end of expansion, whatever that may be; all this computation is necessary to arrive at the two following results, which are the real meat of the matter:

$w =$ the work in foot pounds per unit of heat expended and is found by dividing the total work of one pound of steam by $H + h + 21$. $H = 1118.72$, $h = 183.09$ these two quantities $+ 21. = 1322.81$ and 215575. or $W \div 1322.81 = 162.97$ as the foot pounds of work per unit of heat expended; if it is wished to obtain the efficiency in percentage of the whole heat units expended, divide w by 772, which in this case = 21.11% of the total heat expended, this is without counting clearance space, for no such result as 21% has been realized in any engine the author has ever had under examination, but the formula given, as compared one engine with another, is practically correct in a comparative sense only. $C =$ coal in pounds per horse-power per hour under the above train of conditions $= 33\,000 \times 60 \div w \times$ any factor of units per pound of coal that it may please the computer, if we realized 10,000 units per pound of coal it will be $198 \div 162.97 = 1.2149$ pounds of coal per horse-power per hour, under the conditions stated; this formula may be applied to any expansion engine, single, double, triple or quadruple, and such modification in percentage of loss by clearance, as are expended under the head of clearance, where the formula for correction of efficiency of expansion is given. To apply the same formula to NON-CONDENSING engines the following is necessary: $W = 16.95 \times p_1 v_1 - p_2 v_2$ in which p_1 means absolute pressure $\times 144$, v_1 v_2 are the volumes as in the condensing formula. $H = 965.7 + (305\ t_1 - t_2)$ in which t_1 is the temperature of the steam at absolute pressure, t_2 the temperature of the feed-water which in the non-condensing engine is usually supposed to be nearly or quite 200° F., $H = W \div 772 - (.305 \times t_1 - t_2)$, $w = W \div (H + h)$, $C = 1\,980\,000 \div w \times$ the number of units from a pound of coal. The working out of the formula in each case is precisely similar, paying attention to the change of factors; the condensing engine taking account of what is below the atmospheric line, the non-condensing not including below the atmospheric line.

THE AMOUNT OF WATER OR STEAM ACCOUNTED FOR BY THE INDICATOR DIAGRAM.

The amount of steam or water, for one is the equivalent of the other so nearly as we are able to compute, is usually computed from the termination of the expansion line, and in the case of an early release it is well to carry the theoretical curve by demonstration to the very end of the diagram in order to ascertain what would have been the terminal pressure.

The mean pressure is the usual work done by the engine as accounted for by the indicator. The terminal pressure is, to all intents and purposes, the measurement of the amount of steam used in doing the work, under those conditions, in that engine, and at that time. Neither one of these amounts are absolute from the indicator diagram, indicator springs vary, the clearance is not expressed by the indicator diagram, the amount of the loss of pressure by wire-drawing, can only be partially recorded by the instrument, hence we have to assume somewhat or go to much trouble and expense to ascertain all these factors.

The same applies to the measuring of steam or the water per horsepower, per stroke or per hour, as the case may be. Attempts have been made, very unsuccessfully in result, to arrive at some conclusion as between the steam when cut off, and when released, to arrive at the quantity of water accounted for, to be *added to the apparent* result of the indicator diagram, it will be seen therefore that the quantity of steam actually expended to produce the work on the indicator diagram, would not be accounted for by the indicator, strictly speaking, in a correct or absolute amount.

There are losses between the boiler and the engine which the indicator cannot consider, and there are things which we don't positively know. The formula will be given which applies to any diagram or engine, it may include a series of cylinders, or the problem in its entirety embraces the highest mathematics, and very extended formulæ which cannot be given here, if we take the absolute pressure of the indicator diagram at the point of release, or before the valve actually opens; by referring to the tables, page 71, we shall find the *specific volume* of steam at that pressure, or the number of cubic feet which are in one pound, as well as the density, col. 6, steam table, which gives the weight of one cubic foot, in fractions of a pound. The area of the cylinder in square inches × the length which the piston travels to the point of computation, at which the pressure is taken, gives the volume of the cylinder to that point in cubic inches, and the volume of one stroke × the number of strokes per minute × 2 for (two) strokes to the revolution × 60., the minutes in an hour, ÷ 1728, the inches in a cubic foot, will give the cubic feet of steam at that pressure, whatever that pressure may be. Multiplying the cubic feet of steam used in that cylinder per hour, by the density or weight of one cubic foot, col. 6, page 71, will give the number of pounds either of steam or water accounted for by the indicator for all the work done by that indicator diagram in one hour, the result being in pounds. Divide the number of pounds by the number of horse-powers which the diagram reads and the result is then pounds per horse-power per hour. In figuring the compression measure the pressure from the point where the compression of exhaust line leaves the atmospheric line, if high pressure, measuring the distance to the starting point, or admission line of the diagram, taking the pressure always from the absolute line, multiplying the volume of the cylinder from that point by the inches of area, reducing to cubic feet exactly the same as at the point of release ; deduct this amount from the total of release, all pressure must be measured from the absolute line, or 14.7 lbs. below the atmospheric line of the instrument, whether high pressure or condensing.

In compound cylinders each cylinder may be figured by itself, or a combination diagram may be made in which the high pressure and intermediates must be reduced to low, and in all cases where the correct result is supposed to be arrived at; clearance becomes an important factor of the case, *always include the clearance* if you wish to get a correct result, and in using compound diagrams the clearance on the low and intermediate cylinders must always be figured with reference to ratio between these cylinders and the high, for the diagram must start at precisely the same point, and in making the *clearance* correspond to the high-pressure cylinder the correct result will be had.

The difference in result as between diagrams showing the water accounted for, and the actual water weighed to the boiler, has varied in actual tests from 2¼ to 45 per cent. By taking two or three measurements, as immediately after the cut off, and half stroke, and at the point of release, these three results will be found not to agree with each other ; these questions are still unsettled by scientific men. Prof. Cotterill treats them as clearly as any one, but it requires a knowledge of mathematics to understand it. It will repay any one to spend the time to study the subject thoroughly. Rankine exhausts it, but uses the calculus—requiring the highest talent.

The following computation is purely theoretical, taking an engine having a cylinder 20" in diameter, 42" stroke, running at 100 revolutions, cut off at .25, clearance .5"; steam at 100 pounds absolute, the area of 20" is (see page 68) = 314.16", and on the same page the constant for each foot = .00952007 horse-power for each pound of mean pressure ; the clearance is included in the computation; the length of stroke + the clearance = 42.5"; the cut-off + the .5" clearance = 11 ; 42.5 ÷ 11. = 3.8637 as r' or the accurate ratio of expansion. Now, to obtain the mean pressure, we must have the ε of $r'+1$ (refer to page 54), and add to the ε of 3.86 .3 of the difference between the 3.86 and 3.87; the result is 1.35145+1., and we have ε of $r'+1=2.35145\times 100\div 3.8637=60.861$; this is the absolute M. E. P. of the diagram; $1\div r'=$ the point of cut-off=.25883; having the point of cut-off given turn to table on page 80, look under .259, find .60883×100 =60.883 as the mean pressure, without any other computation, and it is so near to the actual amount by computation, that it would not be worth while using the old formula, except that we must have the point of cut-off to obtain the factor. Having the mean pressure, we find the terminal pressure as follows: The initial = 100, $r'=3.38637$, and 100÷3.8637=25.88 pounds as the terminal pressure from which to figure the amount of steam used, the formula will be 314.16×42.5×200×60÷1728=92721. cubic feet of steam for the 200 strokes, 60 minutes or one hour; steam at the pressure 25.88, see page 71, column six, where 25 lbs.=.062546, the difference between 25 and 26 pounds =.002350×88=.001958, added to the weight of 25 lbs., .062546,=.064504 as the weight of a cubic foot of steam at 25.88 absolute pressure, and 927.21 cubic feet×.064504=5981. pounds of steam or water per hour under the conditions named; this includes clearance.. The horse-power of the engine is, taking the absolute line pressure as above, 60.883—14.7=46.183 pounds above atmospheric line. K. for each pound as above for 1 foot =.00952007×700 feet of piston speed = 6.664049 horse-power for each pound of mean pressure exerted on the piston 20" in diameter and at the speed of 700 feet per minute; then, 46.183 pounds×6.664 horse-power for each pound = 307.765 horse-power developed, and as the total amount of water or steam used in one hour is 5981. pounds, we divide that amount by the horse-power 307.765, and the result is 19.443 pounds of water per hour for each horse-power. This does not take into consideration the loss by wire-drawing, or the compression, or back pressure, at all. The result is worthless as a matter of reference, except as a comparison with another engine in the same way. This shows the proper method of computation from the ideal or any real diagram, having no loss, and being considered as non-condensing. And in a condensing engine whatever vacuum is obtained by the condenser will increase the amount of mean pressure, consequently the horse-power, and the amount of steam accounted for with the same terminal pressure, divided by a larger amount of horse-power, will show less water per horse-power. In figuring steam saved by compression, instructions for which are given above, will sometimes be found to be very insignificant, and at other times it will be a large amount. A large amount of compression is not an economical use of steam, although so considered by some of the high-speed engine builders. The student should include as many different diagrams as possible in comparison, in order to obtain comparative results of economy, always including the clearance. Some of these results will be found to be astonishing.

It is not intended to make this volume a text-book, nor a hand-book of calculations, but some of the most frequently wanted computations are worked out for information of those who are not familiar with the use of the accurate formulæ. The writer has in course of preparation a hand-book of computations on the indicator diagram and its connections, and will be pleased to have, at any time, suggestions as to what is wanted for such computations. No time can be named for its appearance—it may be years—as it is possible to give time to it.

CONDENSING WATER FOR A GIVEN DIAGRAM.

Taking the above engine 20" by 42", by 100 revs. 100 pounds of steam cut off at .25 of the stroke clearance = .5 inches, taking the area of the cylinder ×, the point of cut-off, or the length steam is carried × number of strokes per minute ÷ *relative* volume of the steam, col. 8, pp. 71 to 75, ÷ number of cubic inches in one gallon or 231. × 80. gives the capacity in gallons per minute, with an excess of 10% to 15%, this excess should always be included for the difference in temperature of the water at different seasons of the year, and in the case of a ship going through the torrid zone the excess of capacity should be double this, or 20% to 30%, worked out this is as follows: 314.16 square inches in area × 11, gives the cubic inches of steam required for each stroke, clearance included, × 200 = 691,152. which is the cubic inches of steam required each minute, ÷ the relative volume of steam at 100. pounds absolute pressure = 270.72 = 2553. as the cubic inches of water per minute required to make the steam, and this ÷ 231 = 11.052 gallons per minute as the quantity of steam at the point of cut-off, and this × 80 gives the pump capacity as 884.16 gallons per minute, required to condense steam from the engine under the conditions stated; this rule is not far from a practical one, although it is to some extent an empirical one, the same thing can be figured out by use of heat units, mean pressure, etc., but involves more figures, and does not vary more than 2% or 3%, while temperature of condensing water in New England and the Middle States varies from 25 to 35% during the twelve months of the year.

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The author of this book has for the last five or six years been employed in and out of the United States ; is frequently absent for months at a time. Letters addressed to Post Office Box 2728, Boston, Mass., will reach him wherever he may be in due time. The box may be considered as permanent address.

TO USERS OF INDICATORS.

Parties interested in the manufacture of indicators have circulated the report with diligence, and for their own purposes, that Mr. Pray was interested in the sales of the Thompson Indicator, made by the American Steam Gauge Co., of Boston. Any such report is false in any and all particulars. Thomas Pray, Jr., has not now, and never has had, any connection with the American Steam Gauge Co., nor with the patentee of the Thompson Indicator, or any other company or individual making indicators (or some of the so-called indicators,) either financial or otherwise. Does not and will not advise the use of any particular indicator, and is not interested in the sale of ANY machine, apparatus, patent or scheme.

TABLE OF RATIO OF EXPANSION, CUT OFF, &c.

Cut-off.	R.	$\epsilon + 1$.	Log.	K.	Log.—10.
.01	100.	5.605	0.74858	0.05605	8.74858
.02	50.	4.912	0.69126	0.09822	8.99220
.03	33.3	4.506	0.65379	0.13530	9.13139
.04	25.0	4.219	0.62521	0.16876	9.22727
.05	20.	3.996	0.60163	0.19980	9.30060
.06	16.67	3.813	0.58127	0.22878	9.35942
.07	14.29	3.660	0.56348	0.25620	9.40858
.08	12.50	3.526	0.54728	0.28208	9.45037
.09	11.11	3.408	0.53250	0.30672	9.48674
.10	10.00	3.303	0.51891	0.33026	9.51891
.11	9.09	3.207	0.50610	0.35278	9.54749
.12	8.33	3.120	0.49415	0.37433	9.57333
.13	7.69	3.040	0.48287	0.39519	9.59681
.14	7.14	2.966	0.47217	0.41524	9.61830
.15	6.67	2.898	0.46210	0.43470	9.63819
.16	6.25	2.830	0.45179	0.45280	9.65591
.17	5.88	2.770	0.44248	0.47090	9.67293
.18	5.56	2.716	0.43393	0.48888	9.68920
.19	5.26	2.661	0.42504	0.50558	9.70379
.20	5.00	2.609	0.41647	0.52180	9.71750
.21	4.76	2.561	0.40841	0.53781	9.73063
.22	4.55	2.515	0.40054	0.55330	9.74296
.23	4.35	2.470	0.39270	0.56811	9.75443
.24	4.17	2.428	0.38525	0.58271	9.76546
.25	4.00	2.386	0.37767	0.59650	9.77561
.26	3.846	2.347	0.37051	0.61021	9.78548
.27	3.704	2.310	0.36361	0.62369	9.79497
.28	3.571	2.273	0.35660	0.63644	9.80376
.29	3.448	2.238	0.34986	0.64903	9.81226
.30	3.334	2.204	0.34321	0.66120	9.82033
.31	3.226	2.171	0.33666	0.67301	9.82802
.32	3.125	2.140	0.33041	0.68480	9.83556
.33	3.0303	2.109	0.32408	0.69598	9.84259
.34	2.9411	2.079	0.31785	0.70685	9.84933
.35	2.8571	2.050	0.31175	0.71750	9.85582
.36	2.7778	2.022	0.30578	0.72791	9.86208
.37	2.7027	1.994	0.29973	0.73780	9.86793
.38	2.6316	1.968	0.29403	0.74782	9.87381
.39	2.5641	1.942	0.28825	0.75738	9.87931
.40	2.5000	1.917	0.28262	0.76680	9.88468
.41	2.4390	1.892	0.27692	0.77570	9.88970
.42	2.3810	1.868	0.27138	0.78460	9.89463
.43	2.3257	1.844	0.26576	0.79290	9.89923
.44	2.2727	1.821	0.26031	0.80122	9.90376
.45	2.2222	1.799	0.25503	0.80951	9.90824
.46	2.1740	1.777	0.24969	0.81742	9.91245
.47	2.1277	1.755	0.24428	0.82490	9.91638
.48	2.0833	1.734	0.23905	0.83257	9.92029
.49	2.0408	1.713	0.23376	0.83940	9.92396
.50	2.0000	1.693	0.22866	0.84650	9.92763
.51	1.961	1.674	0.22376	0.85374	9.93133
.52	1.923	1.654	0.21854	0.86007	9.93454
.53	1.887	1.635	0.21352	0.86660	9.93780
.54	1.852	1.616	0.20844	0.87263	9.94083

TABLE OF RATIO OF EXPANSION, CUT OFF, &c.

Cut-off.	R.	e + 1.	Log.	K.	Log.—10.
.55	1.818	1.598	0.20358	0.87891	9.94394
.56	1.786	1.580	0.19866	0.88481	9.94685
.57	1.754	1.562	0.19368	0.89033	9.94955
.58	1.724	1.545	0.18893	0.89610	9.95236
.59	1.695	1.528	0.18412	0.90151	9.95497
.60	1.667	1.511	0.17926	0.90659	9.95741
.61	1.639	1.494	0.17435	0.91134	9.95968
.62	1.613	1.478	0.16967	0.91635	9.96206
.63	1.587	1.462	0.16495	0.92107	9.96429
.64	1.563	1.446	0.16017	0.92545	9.96635
.65	1.538	1.431	0.15564	0.93015	9.96855
.66	1.515	1.416	0.15106	0.93455	9.97060
.67	1.493	1.400	0.14613	0.93826	9.97232
.68	1.471	1.386	0.14176	0.94248	9.97427
.69	1.449	1.371	0.13704	0.94677	9.97624
.70	1.429	1.357	0.13258	0.94991	9.97768
.71	1.409	1.342	0.12775	0.95282	9.97901
.72	1.389	1.329	0.12353	0.95689	9.98086
.73	1.370	1.315	0.11893	0.95996	9.98225
.74	1.351	1.301	0.11428	0.96275	9.98351
.75	1.333	1.287	0.10958	0.96548	9.98474
.76	1.316	1.274	0.10517	0.96823	9.98598
.77	1.299	1.262	0.10106	0.97090	9.98721
.78	1.282	1.248	0.09621	0.97342	9.98830
.79	1.266	1.236	0.09202	0.97645	9.98965
.80	1.250	1.223	0.08743	0.97841	9.99052
.81	1.245	1.211	0.08314	0.98092	9.99163
.82	1.220	1.198	0.07846	0.98236	9.99227
.83	1.205	1.186	0.07408	0.98438	9.99316
.84	1.191	1.174	0.06967	0.98617	9.99395
.85	1.177	1.163	0.06558	0.98813	9.99481
.86	1.163	1.151	0.06108	0.98986	9.99557
.87	1.149	1.139	0.05662	0.99093	9.99604
.88	1.136	1.128	0.05231	0.99264	9.99679
.89	1.124	1.117	0.04805	0.99413	9.99744
.90	1.111	1.106	0 04376	0.99541	9.99800
.91	1.099	1.094	0.03902	0.99555	9.99806
.92	1.087	1.084	0.03503	0.99729	9.99882
.93	1.075	1.073	0.03060	0.99789	9.99908
.94	1.064	1.062	0.02612	0.99828	9.99925
.95	1.053	1.051	0.02160	0.99844	9.99932
.96	1.042	1.041	0.01745	0.99918	9.99964
.97	1.0309	1.0304	0.01301	0.99959	9.99982
.98	1.0204	1.0202	0.00869	0.99980	9.99991
.99	1.0101	1.01005	0.00434	0.99990	9.99996

HEAT UNITS IN WATER, 32°F. TO 212°F.,

And weight of water per cubic foot, each degree, F. 32° to 212°. Heat (Regnault's), weight (Rankine's, computed by author), from 32° F.

F°	Heat Units.	Weight, 1 cubic foot.	Log.	Weight of U. S. Gallon in lbs.	Log.	Cubic inches in one pound.	Log.
32	0.	62.420	1.79532	8.3443	0.92139	27.6840	1.44222
3	1.	62.421	533	8.3445	140	27.6830	221
4	2.	62.423	534	8.3447	141	27.6820	220
5	3.	62.424	535	8.3449	142	27.6817	219
6	4.	62.425	536	8.3451	143	27.6812	218
7	5.	62.425	536	8.3451	143	27.6812	218
8	6.	62.425	536	8.3451	143	27.6812	218
9.1	7.001	62.425	536	8.3451	143	27.6812	1.44218
40	8.001	62.425	536	8.3451	143	27.6812	218
1	9.001	62.425	536	8.3451	143	27.6812	218
2	10.001	62.424	535	8.3449	142	27.6817	219
3	11.001	62.423	534	8.3447	141	27.6820	220
4	12.002	62.422	534	8.3447	141	27.6820	220
5	13.002	62.421	533	8.3445	140	27.6830	221
6	14.002	62.420	532	8.3443	139	27.6840	222
7	15.002	62.417	530	8.3439	137	27.6850	224
8	16.003	62.415	529	8.3438	136	27.6855	225
9	17.003	62.414	528	8.3436	135	27.6860	226
50	18.003	62.412	527	8.3434	134	27.6867	1.44227
1	19.004	62.410	525	8.3430	132	27.6880	229
2	20.004	62.407	523	8.3426	130	27.6892	231
3	21.005	62.400	518	8.3416	125	27.6924	236
4	22.005	62.394	514	8.3409	121	27.6950	240
5	23.006	62.389	511	8.3403	118	27.6970	243
6	24.006	62.385	508	8.3397	115	27.6980	246
7	25.007	62.382	506	8.3394	113	27.7000	248
8	26.007	62.379	504	8.3390	111	27.7015	250
9	27.008	62.371	1.79498	8.3378	105	27.7050	256
60	28.009	62.364	493	8.3369	100	27.7084	1.44261
1	29.010	62.362	492	8.3366	0.92099	27.7090	262
2	30.011	62.361	491	8.3365	098	27.7097	263
3	31.012	62.355	487	8.3357	094	27.7122	267
4	32.013	62.349	483	8.3349	090	27.7150	271
5	33.014	62.344	479	8.3342	086	27.7173	275
6	34.015	62.339	476	8.3336	083	27.7192	278
7	35.016	62.332	471	8.3326	078	27.7224	283
8	36.018	62.326	467	8.3318	074	27.7250	287
9	37.019	62.321	463	8.3311	070	27.7275	1.44291
70	38.020	62.312	457	8.3299	064	27.7307	297
1	39.021	62.305	452	8.3290	059	27.7345	302
2	40.023	62.298	447	8.3280	054	27.7377	307
3	41.024	62.289	441	8.3268	048	27.7415	313
4	42.026	62.282	436	8.3259	043	27.7450	318
5	43.027	62.275	431	8.3249	038	27.7480	323
6	44.029	62.266	425	8.3238	032	27.7511	329
7	45.030	62.259	420	8.3228	027	27.7550	334
8	46.032	62.250	414	8.3217	021	27.7590	340
9	47.034	62.243	409	8.3207	016	27.7620	345

HEAT UNITS IN WATER.—*Continued.*

F°	Heat Units.	Weight, 1 cubic foot.	Log.	Weight of U. S. Gallon in lbs.	Log.	Cubic inches in one pound.	Log.
80	48.036	62.236	1.79404	8.3198	0.92011	27.7652	1.44350
1	49.037	62.226	1.79397	8.3184	004	27.7697	357
2	50.039	62.214	389	8.3169	0.91996	27.7750	365
3	51.041	62.204	382	8.3155	989	27.7791	372
4	52.043	62.194	375	8.3142	982	27.7840	379
5	53.045	62.186	369	8.3131	976	27.7876	385
6	54.047	62.174	361	8.3115	968	27.7921	393
7	55.049	62.164	354	8.3102	961	27.7980	1.44400
8	56.051	62.153	346	8.3087	953	27.8030	408
9	57.053	62.143	339	8.3073	946	27.8070	415
90	58.055	62.133	332	8.3060	939	27.8112	422
1	59.057	62.121	324	8.3044	931	27.8166	430
2	60.059	62.110	316	8.3029	923	27.8210	438
3	61.061	62.099	308	8.3014	915	27.8267	446
4	62.063	62.087	300	8.2999	907	27.8320	454
5	63.065	62.076	1.79292	8.2983	0.91899	27.8370	462
6	64.068	62.066	285	8.2970	892	27.8414	469
7	65.071	62.051	275	8.2951	882	27.8471	479
8	66.074	62.039	266	8.2934	873	27.8537	488
9	67.077	62.026	257	8.2915	863	27.8600	498
100	68.080	62.013	248	8.2809	855	27.8650	1.44506
1	69.083	62.000	239	8.2882	846	27.8710	515
2	70.086	61.988	230	8.2865	837	27.8766	524
3	71.089	61.974	221	8.2848	828	27.8820	533
4	72.092	61.963	213	8.2832	820	27.8876	541
5	73.095	61.949	203	8.2813	810	27.8940	551
6	74.098	61.934	1.79193	8.2794	800	27.9004	561
7	75.101	61.921	184	8.2777	0.91791	27.9062	570
8	76.104	61.907	174	8.2758	781	27.9129	580
9	77.108	61.893	164	8.2739	771	27.9190	590
110	78.110	61.880	155	8.2722	762	27.9250	599
1	79.113	61.866	145	8.2703	752	27.9312	1.44609
2	80.117	61.852	135	8.2684	742	27.9378	619
3	81.121	61.837	125	8.2665	732	27.9442	629
4	82.125	61.822	114	8.2644	721	27.9512	640
5	83.129	61.808	104	8.2625	711	27.9576	650
6	84.133	61.793	1.79094	8.2606	701	27.9641	660
7	85.137	61.776	082	8.2583	0.91689	27.9720	672
8	86.141	61.761	071	8.2562	678	27.9790	683
9	87.145	61.745	060	8.2541	667	27.9860	694
120	88.149	61.728	048	8.2518	655	27.9940	1.44706
1	89.153	61.712	037	8.2497	644	28.0010	717
2	90.157	61.696	026	8.2477	633	28.0080	728
3	91.161	61.681	015	8.2456	622	28.0150	739
4	92.165	61.664	003	8.2433	610	28.0230	751
5	93.169	61.647	1.78991	8.2410	0.91598	28.0305	763
6	94.173	61.631	980	8.2389	587	28.0376	774
7	95.177	61.614	968	8.2366	575	28.0453	786
8	96.182	61.597	956	8.2344	563	28.0531	798
9	97.187	61.580	944	8.2321	551	28.0610	1.44810
130	98.192	61.563	932	8.2298	539	28.0685	822
131	99.197	61.545	1.78919	8.2274	0.91526	28.0770	1.44835
2	100.202	61.528	907	8.2251	514	28.0850	847

HEAT UNITS IN WATER.—*Continued.*

F°	Heat Units.	Weight, 1 cubic foot.	Log.	Weight of U. S. Gallon in lbs.	Log.	Cubic inches in one pound.	Log.
133	101.207	61.509	1.78894	8.2226	0.91501	28.0931	860
4	102.212	61.492	882	8.2204	0.91489	28.1010	872
5	103.217	61.475	870	8.2181	477	28.1086	884
6	104.222	61.457	857	8.2156	464	28.1170	897
7	105.227	61.439	844	8.2132	451	28.1255	1.44910
8	106.233	61.422	832	8.2109	439	28.1334	922
9	107.239	61.399	816	8.2079	423	28.1437	938
140	108.245	61.378	801	8.2050	408	28.1535	953
1	109.251	61.357	1.78786	8.2022	0.91393	28.1632	968
2	110.257	61.341	775	8.2001	382	28.1702	979
3	111.263	61.324	763	8.1979	370	28.1780	991
4	112.269	61.309	752	8.1958	359	28.1851	1.45002
5	113.275	61.289	738	8.1931	345	28.1943	016
6	114.281	61.269	724	8.1905	331	28.2034	030
7	115.287	61.251	711	8.1881	318	28.2120	043
8	116.293	61.231	1.78697	8.1854	304	28.2210	057
9	117.299	61.212	683	8.1828	0.91290	28.2300	071
150	118.305	61.192	669	8.1801	276	28.2390	085
1	119.311	61.172	655	8.1775	262	28.2482	099
2	120.318	61.152	641	8.1749	248	28.2640	1.45123
3	121.325	61.133	627	8.1722	234	28.2664	127
4	122.332	61.113	613	8.1696	220	28.2755	141
5	123.339	61.093	1.78599	8.1670	206	28.2846	155
6	124.347	61.075	586	8.1645	0.91193	28.2930	168
7	125.354	61.052	570	8.1615	177	28.3035	184
8	126.361	61.031	555	8.1587	162	28.3133	199
9	127.366	61.009	539	8.1557	146	28.3244	1.45215
160	128.373	60.988	524	8.1529	131	28.3335	230
1	129.380	60.967	509	8.1501	116	28.3433	245
2	130.389	60.945	1.78494	8.1472	101	28.3530	260
3	131.396	60.923	478	8.1442	0.91085	28.3635	276
4	132.404	60.902	463	8.1414	070	28.3733	291
5	133.413	60.881	448	8.1386	055	28.3831	1.45306
6	134.421	60.859	432	8.1356	039	28.3936	322
7	135.430	60.837	417	8.1328	024	28.4034	337
8	136.436	60.817	402	8.1300	009	28.4132	352
9	137.444	60.794	1.78386	8.1270	0.90993	28.4236	368
170	138.451	60.772	370	8.1240	977	28.4340	384
1	139.460	60.751	355	8.1212	962	28.4440	399
2	140.470	60.723	339	8.1182	946	28.4545	1.45415
3	141.480	60.706	323	8.1152	930	28.4650	431
4	142.489	60.684	307	8.1122	914	28.4755	447
5	143.496	60.661	1.78291	8.1093	0.90898	28.4860	463
6	144.505	60.639	275	8.1063	882	28.4965	479
7	145.516	60.617	259	8.1033	866	28.5070	495
8	146.524	60.593	242	8.1001	849	28.5180	1.45512
9	147.533	60.571	226	8.0971	833	28.5286	528
180	148.542	60.548	1.78210	8.0941	817	28.5390	544
1	149.550	60.525	1.78193	8.0910	0.90800	28.5502	1.45561
2	150.562	60.501	176	8.0878	0.90783	28.5615	578
3	151.570	60.479	160	8.0849	767	28.5720	594
4	152.580	60.455	143	8.0817	750	28.5832	1.45611
5	153.590	60.431	126	8.0785	733	28.5944	628

HEAT UNITS IN WATER.—*Concluded.*

F°	Heat Units.	Weight, 1 cubic foot.	Log.	Weight of U. S. Gallon in lbs.	Log.	Cubic inches in one pound.	Log.
186	154.600	60.408	109	8.0754	716	28.6055	645
7	155.610	60.384	1.78092	8.0722	0.90699	28.6170	662
8	156.621	60.360	075	8.0690	682	28.6280	679
9	157.633	60.338	059	8.0661	666	28.6385	695
190	158.643	60.313	041	8.0627	648	28.6505	1.45713
1	159.654	60.288	023	8.0594	630	28.6622	731
2	160.666	60.265	006	8.0562	613	28.6735	748
3	161.676	60.240	1.77988	8.0529	0.90595	28.6851	766
4	162.686	60.216	971	8.0497	578	28.6966	783
5	163.696	60.193	954	8.0466	561	28.7080	1.45800
6	164.707	60.167	936	8.0433	543	28.7200	818
7	165.718	60.144	919	8.0401	526	28.7310	835
8	166.729	60.120	902	8.0370	509	28.7422	852
9	167.740	60.095	1.77884	8.0336	0.90491	28.7541	870
200	168.752	60.071	866	8.0303	473	28.7660	888
1	169.764	60.047	849	8.0272	456	28.7774	1.45905
2	170.776	60.022	831	8.0238	438	28.7892	923
3	171.790	59.997	813	8.0205	420	28.8013	941
4	172.801	59.974	1.77796	8.0174	403	28.8125	958
5	173.812	59.947	777	8.0139	0.90384	28.8250	977
6	174.826	59.921	758	8.0104	365	28.8377	996
7	175.837	59.895	739	8.0069	346	28.8503	1.46015
8	176.848	59.869	720	8.0034	327	28.8630	034
9	177.860	59.844	702	8.0000	309	28.8750	052
210	178.873	59.819	1.77684	7.9967	0.90291	28.8870	070
11	179.889	59.793	665	7.9932	272	28.8996	089
12	180.899	59.768	647	7.9899	254	28.9117	1.46107
13	181.913	59.744	1.77629	7.9866	0.90236	28.9237	125

FACTORS OF EVAPORATION: The Equivalent of (from and at 212F°.)

This table calls for the figure one, when used, to be put before the decimal. Decimals only are given in this table.

Abs. lbs. Temp., F°.

Lbs. Feed Water°	15 213°	20 227.9°	25 240°	30 250.25°	40 267.1°	50 280.85°	60 292.5°	70 302.7°	75 307.4°
32	1.1876	1.1923	1.1962	1.1995	1.2047	1.2091	1.2128	1.2160	1.2174
3	66	13	52	85	37	81	18	50	64
4	56	.1903	42	75	27	71	.2108	40	54
5	45	.1892	31	64	16	60	.2097	29	43
6	34	81	20	54	.2006	50	87	19	33
7	24	71	10	43	.1995	39	76	.2108	22
8	14	61	.1900	33	85	29	66	.2008	12
9	.1804	51	.1890	23	75	19	56	88	.2102
40	.1793	40	79	12	64	.2008	45	77	.2091
1	83	30	68	.1901	53	.1997	34	66	80
2	73	20	59	.1892	44	88	25	57	71
3	62	.1809	48	81	33	77	14	46	60
4	52	.1799	37	70	22	66	.2003	35	49
5	42	89	28	61	13	57	.1994	26	40
6	31	78	17	50	.1902	46	83	15	29
7	21	68	.1806	39	.1891	35	72	.2004	18
8	10	57	.1796	29	81	25	62	.1995	.2009
9	.1700	47	86	19	71	15	52	84	.1998
50	.1690	37	75	.1808	60	.1904	41	73	87
1	79	26	65	.1798	50	.1894	31	63	77
2	69	16	55	88	40	84	21	53	67
3	59	.1706	44	77	29	73	10	42	56
4	48	.1695	34	67	19	63	.1900	32	46
5	38	85	24	57	.1809	53	.1890	22	36
6	28	75	13	46	.1799	43	80	12	26
7	17	64	.1703	36	88	32	69	.1901	15
8	.1607	54	.1693	26	78	22	59	.1891	.1905
9	.1597	44	82	15	67	11	48	80	.1894
60	86	33	72	.1705	57	.1801	38	70	84
1	76	23	62	.1695	47	.1791	28	60	74
2	66	13	51	84	36	80	17	49	63
3	56	.1603	42	75	27	71	.1808	40	54
4	45	.1592	31	64	16	60	.1797	29	43
5	35	82	20	53	.1705	49	86	18	32
6	24	71	.1609	42	.1694	38	75	.1807	21
7	14	61	.1599	32	84	28	65	.1797	11
8	.1504	51	89	22	74	18	55	87	.1801
9	.1493	40	79	12	64	.1708	45	77	.1791
70	82	29	68	.1601	53	.1697	34	66	80
1	72	19	58	.1591	42	86	23	55	69
2	61	.1508	47	80	32	76	13	45	59
3	51	.1498	37	70	22	66	.1703	35	49
4	41	88	26	59	11	55	.1692	24	38
5	31	78	16	49	.1601	45	82	14	28
6	20	67	.1506	39	.1591	35	72	.1704	18
7	.1410	57	.1495	28	80	24	61	.1693	.1707
8	.1399	46	85	18	70	14	51	83	.1697
9	89	36	75	.1508	60	.1604	41	73	87

FACTORS OF EVAPORATION.—*Continued.*

Lbs.	15	20	25	80	40	50	60	70	75
Feed Water°	213°	227.9°	240°	250 25°	267.1°	280.85°	292.5°	302.7°	307 4
80	.1379	.1426	.1464	.1496	.1549	.1593	.1630	.1662	.1676
1	69	16	54	87	39	83	20	52	66
2	58	.1405	44	76	29	73	10	42	56
3	48	.1395	32	65	19	63	.1599	31	45
4	37	84	22	55	.1509	53	88	20	34
5	27	74	12	45	.1499	43	78	10	24
6	17	64	.1402	35	88	32	68	.1600	14
7	.1307	54	.1392	25	78	22	58	.1590	.1604
8	.1296	43	82	15	68	12	48	80	.1594
9	86	33	71	.1404	57	.1501	37	69	83
90	75	22	61	.1394	47	.1491	27	59	73
1	65	12	51	84	37	81	17	49	63
2	55	.1302	40	73	26	70	.1506	38	52
3	44	.1291	30	63	16	60	.1496	28	42
4	33	80	20	53	.1406	50	86	18	32
5	23	70	.1309	42	.1395	39	75	.1507	21
6	13	60	.1298	31	84	28	64	.1496	.1510
7	.1202	49	87	20	73	17	53	85	.1499
8	.1192	39	77	10	63	.1407	43	75	89
9	81	28	67	.1300	53	.1397	33	65	79
100	71	18	56	.1289	42	86	22	54	68
1	61	.1208	46	79	32	76	12	44	58
2	51	.1198	35	68	21	65	.1401	33	47
3	40	87	25	58	11	55	.1391	23	37
4	30	77	15	48	.1301	45	81	13	27
5	19	66	.1204	37	.1290	34	70	.1402	16
6	.1109	56	.1194	27	80	24	60	.1392	.1406
7	.1099	46	84	17	70	14	50	82	.1396
8	88	35	73	.1206	59	.1303	39	72	86
9	78	25	63	.1196	49	.1293	29	61	75
110	68	15	53	85	38	82	18	50	64
1	57	.1104	42	75	28	72	.1308	40	54
2	46	.1093	32	65	18	62	.1298	30	44
3	36	83	22	55	.1208	52	88	20	34
4	25	72	11	44	.1197	41	77	.1309	23
5	15	62	.1100	33	86	30	66	.1298	12
6	.1005	52	.1090	23	76	20	56	88	.1302
7	.0994	41	79	12	65	.1209	45	77	.1291
8	84	31	69	.1102	54	.1198	35	67	81
9	74	21	59	.1092	44	88	25	57	71
120	64	11	48	81	34	78	14	46	60
1	53	.1000	38	71	24	68	.1204	36	50
2	43	.0990	28	61	14	58	.1194	26	40
3	33	80	18	51	.1104	48	84	16	30
4	22	69	.1007	40	.1093	37	73	.1205	19
5	12	59	.0997	30	83	27	63	.1195	.1209
6	.0902	49	87	20	73	17	53	85	.1199
7	.0891	38	76	.1009	62	.1106	42	74	88
8	81	28	66	.0999	52	.1096	32	64	78
9	70	17	55	88	41	85	21	53	67
130	59	.0906	44	77	30	74	10	42	56
1	49	.0896	34	67	20	64	.1100	32	46

FACTORS OF EVAPORATION.—*Continued.*

Lbs.	15	20	25	30	40	50	60	70	75
Feed Water°	213°	227.9°	240°	250.25°	267.1	280.85°	292.5°	302.7°	307.4°
132	.0838	.0885	.0924	.0957	.1010	.1054	.1090	.1122	.1136
3	28	75	14	47	.1000	44	80	12	26
4	18	65	.0903	36	.0988	32	69	.1101	15
5	.0808	55	.0893	26	78	22	59	.1091	.1105
6	.0798	45	83	16	68	12	49	81	.1095
7	87	34	72	.0905	57	.1001	38	70	84
8	77	24	62	.0895	47	.0991	28	60	74
9	66	13	51	84	36	80	17	49	63
140	56	.0803	41	74	26	70	.1007	39	53
1	45	.0792	30	63	15	59	.0996	28	42
2	34	81	19	52	.0904	48	85	17	31
3	24	71	.0809	42	.0894	38	75	.1007	21
4	14	61	.0799	32	84	28	65	.0997	11
5	.0704	51	89	22	74	18	55	87	.1001
6	.0693	40	78	11	63	.0907	44	76	.0990
7	82	29	67	.0800	52	.0896	33	65	79
8	72	19	57	.0790	42	86	23	55	69
9	62	.0709	47	80	32	76	13	45	59
150	52	.0699	37	70	22	66	.0903	35	49
1	41	88	26	59	11	55	.0892	24	38
2	31	78	16	49	.0801	45	82	14	28
3	20	67	.0705	38	.0790	34	71	.0903	17
4	.0609	56	.0694	27	79	23	60	.0892	.0906
5	.0599	46	84	17	69	13	50	82	.0896
6	89	36	74	.0707	59	.0803	40	72	86
7	78	25	63	.0696	48	.0792	29	61	75
8	68	15	53	86	38	82	19	51	65
9	58	.0605	43	76	28	72	.0809	41	55
160	48	.0595	33	66	18	62	.0799	31	45
1	37	84	22	55	.0707	51	88	20	34
2	26	73	11	44	.0696	40	77	.0809	23
3	15	62	.0600	33	85	29	66	.0798	12
4	.0505	52	.0590	23	75	19	56	88	.0802
5	.0495	42	80	13	65	.0709	46	78	.0792
6	84	31	69	.0602	55	.0699	36	68	82
7	74	21	59	.0592	44	88	25	57	71
8	64	11	49	82	34	78	15	47	61
9	53	.0500	38	71	23	67	.0704	36	50
170	43	.0490	28	61	13	57	.0694	26	40
1	32	79	17	50	.0602	46	83	15	29
2	21	68	.0506	39	.0591	35	72	.0704	18
3	11	58	.0496	29	81	25	62	.0694	.0708
4	.0401	48	86	19	71	15	52	84	.0698
5	.0391	38	76	.0509	61	.0605	42	74	88
6	80	27	65	.0498	50	.0594	31	63	77
7	70	17	55	88	40	84	21	53	67
8	60	.0407	45	78	30	74	11	43	57
9	49	.0396	34	67	19	63	.0600	32	46
180	38	85	23	56	.0508	52	.0589	21	35
1	27	74	12	45	.0497	41	78	10	24
2	17	64	.0403	35	87	31	68	.0600	14
3	.0307	54	.0392	25	77	21	58	.0590	.0604

FACTORS OF EVAPORATION.—*Continued.*

Lbs.	15	20	25	30	40	50	60	70	75
Feed Water°	213°	227.9°	240°	250.25°	267 1°	280.85°	292 5°	302.7°	307.4°
184	.0297	.0344	.0382	.0414	.0467	.0511	.0548	.0580	.0594
5	86	33	71	.0404	56	.0500	37	69	83
6	76	23	61	.0394	46	.0490	27	59	73
7	66	13	51	84	36	80	17	49	63
8	55	.0302	40	73	25	69	.0506	38	52
9	45	.0292	30	63	15	59	.0496	28	42
190	34	81	19	52	.0404	48	85	17	31
1	23	70	.0308	41	.0393	37	74	.0506	20
2	13	60	.0298	31	83	27	64	.0496	11
3	.0203	50	88	21	73	17	54	86	.0500
4	.0192	39	77	.0310	62	.0406	43	75	.0490
5	81	28	66	.0299	51	.0305	32	64	78
6	70	17	55	88	40	84	21	53	67
7	60	.0207	45	78	30	74	11	43	57
8	50	.0197	35	68	20	64	.0401	33	47
9	40	87	25	58	.0310	54	.0391	23	37
200	29	76	14	47	.0299	43	80	12	26
1	19	66	.0204	37	89	33	70	.0402	16
2	.0109	56	.0194	27	79	23	60	.0392	.0406
3	.0098	45	83	16	68	12	49	82	.0396
4	87	34	72	.0205	57	.0301	38	70	84
5	76	23	61	.0194	46	.0290	27	59	73
6	66	13	51	84	36	80	17	49	63
7	56	.0103	41	74	26	70	.0307	39	53
8	45	.0092	30	63	15	59	.0296	28	42
9	35	82	20	53	.0205	48	85	17	31
210	24	71	.0109	42	.0194	38	75	.0307	21
11	14	61	.0099	32	84	28	65	.0297	11
12	.0003	.0050	.0089	.0121	.0174	.0218	.0255	.0287	.0301
K	.00094	.00078	.00064	.00053	.00044	.00037	.00032	.00028	.00028

NOTE.—The figures at the foot of the page, at bottom of each column, are Constants for each pound of pressure between that column and the next one beyond it **only**, and for each or any degree from 32 to 212. If the exact Factor is wanted, add the decimal as many times as there is difference in pounds to the Factor from that column, and you have the precise factor of evaporation for **any** degree and every pound of the absolute pressure, from 15 lbs. absolute up to two hundred pounds. Example: wanted, the factor for 113 lbs. and 79° F. From 110 lbs. take 79° = 1.1774, then three times .00020 is .00060, and 1.1774 + .00060 = 1.1780, which is exact, and so for any pressure or degree. The line K is Constant for that line of pressure only (top of page), but for any degree of that line of pressure, from 32 to 212, and between the pressure in pounds (absolute) per square inch, over the K and the next column to the right. The last K on the page goes to the first column on the next page.

FACTORS OF EVAPORATION (SECTION 2).

Abs. lbs. Temp., F°.

Lbs. / Feed Water°	80 311.8°	90 320+°	100 327.6°	105 331.1°	110 334 52°	115 337.81°	120 341°	125 344.1°	130 347.1°
32	.2188	.2215	.2238	.2249	.2260	.2270	.2280	.2290	.2300
3	78	.2204	28	39	50	60	70	80	.2290
4	68	.2194	18	29	40	50	60	70	80
5	58	84	.2208	19	30	40	50	60	70
6	47	73	.2197	.2208	19	29	39	49	59
7	37	63	87	.2198	.2209	19	29	39	49
8	27	53	77	88	.2199	.2209	19	29	39
9	17	43	67	78	89	.2199	.2209	19	29
40	.2106	32	56	67	78	88	.2198	.2208	18
1	.2096	22	46	57	68	78	88	.2198	.2208
2	86	12	36	47	58	68	78	88	.2198
3	76	.2102	26	37	48	58	68	78	88
4	65	.2091	15	26	37	47	57	67	77
5	55	81	.2105	16	27	37	47	57	67
6	45	71	.2095	.2106	17	27	37	47	57
7	35	61	85	.2096	.2107	17	27	37	47
8	24	50	74	85	.2096	.2106	16	26	36
9	13	39	63	74	85	.2095	.2105	15	25
50	.2002	28	52	63	74	84	.2094	.2104	14
1	.1991	17	41	52	63	73	83	.2093	.2103
2	81	.2007	31	42	53	63	73	83	.2093
3	71	.1997	21	32	43	53	63	73	83
4	60	86	10	21	32	42	52	62	72
5	50	76	.2000	11	22	32	42	52	62
6	40	66	.1990	.2001	12	22	32	42	52
7	29	55	79	.1990	.2001	11	21	31	41
8	19	45	69	80	.1991	.2001	11	21	31
9	.1908	34	58	69	80	.1990	.2000	10	20
60	.1898	24	48	59	70	80	.1990	.2000	10
1	88	14	38	49	60	70	80	.1990	.2000
2	78	.1904	28	39	50	60	70	80	.1990
3	67	.1893	17	28	39	49	59	69	79
4	57	83	.1907	18	29	39	49	59	69
5	47	73	.1897	.1908	19	29	39	49	59
6	36	62	86	.1897	.1908	18	28	38	48
7	26	52	76	87	.1898	.1908	18	28	38
8	16	42	66	77	88	.1898	.1908	18	28
9	.1805	31	55	66	77	87	.1897	.1907	17
70	.1795	21	45	55	66	76	86	.1896	.1906
1	85	11	35	46	57	67	77	87	.1897
2	74	.1800	24	35	46	56	66	76	86
3	64	.1790	14	25	36	46	56	66	76
4	54	80	.1804	15	26	36	46	56	66
5	43	69	.1793	.1804	15	25	35	45	55
6	33	59	83	.1794	.1805	15	25	35	45
7	23	49	73	84	1795	.1805	15	25	35
8	12	38	62	73	84	.1794	.1804	14	24
9	.1702	28	52	63	74	84	.1794	.1804	14

FACTORS OF EVAPORATION (SECTION 2).—*Continued.*

Lbs.	80	90	100	105	110	115	120	125	130
Feed Water°	311.8°	320+°	327.6°	331 1°	334.52°	337.81°	341°	344.1°	347.1°
80	.1691	.1717	.1741	.1752	.1763	.1773	.1783	.1793	.1803
1	81	.1707	31	42	53	63	73	83	.1793
2	71	.1697	21	32	43	53	63	73	83
3	60	86	09	21	32	42	52	62	71
4	50	76	.1700	11	22	32	42	52	62
5	40	66	.1690	.1701	12	22	32	42	52
6	29	55	79	.1690	.1701	11	21	31	41
7	19	45	69	80	.1691	.1701	11	21	31
8	.1609	35	59	70	80	.1690	.1700	10	20
9	.1598	24	48	59	70	80	.1690	.1700	10
90	88	14	38	49	60	70	80	.1690	.1700
1	77	.1603	27	38	49	59	69	79	.1689
2	67	.1593	17	28	39	49	59	69	79
3	56	82	.1606	17	28	38	48	58	68
4	46	72	.1596	.1607	18	28	38	48	58
5	35	61	85	.1596	.1607	17	27	37	47
6	25	51	75	86	.1597	.1607	17	27	37
7	14	40	64	75	86	.1596	.1606	16	26
8	.1504	30	54	65	76	86	.1596	.1606	16
9	93	19	43	54	65	75	85	.1595	.1605
100	.1483	.1509	33	44	55	65	75	85	.1595
1	73	.1499	23	34	45	55	65	75	85
2	62	88	12	23	34	44	54	64	74
3	52	78	.1502	13	24	34	44	54	64
4	41	67	.1491	.1502	13	23	33	43	53
5	31	57	81	.1492	.1503	13	23	33	43
6	20	46	70	81	.1492	.1502	12	22	32
7	10	36	60	71	82	.1492	.1502	12	22
8	.1400	26	50	61	72	82	.1492	.1502	12
9	.1389	15	39	50	61	71	81	.1491	.1501
110	.1379	.1405	29	40	51	61	71	81	.1491
1	68	.1394	19	30	41	51	61	71	81
2	58	84	.1408	19	30	40	50	60	70
3	47	73	.1397	.1408	19	29	39	49	59
4	37	63	87	.1398	.1409	19	29	39	49
5	27	53	77	88	.1399	.1409	19	29	39
6	16	42	66	77	88	.1398	.1408	18	28
7	.1306	32	56	67	78	88	.1398	.1408	18
8	.1296	22	46	57	68	78	88	.1398	.1408
9	85	11	35	46	57	67	77	87	.1397
120	75	.1301	25	36	47	57	67	77	87
1	64	.1290	14	25	36	46	56	66	76
2	54	80	.1304	15	26	36	46	56	66
3	44	70	.1294	.1305	16	26	36	46	56
4	33	59	83	.1294	.1305	15	25	35	45
5	23	49	73	84	.1295	.1305	15	25	35
6	13	39	63	74	85	.1295	.1305	15	25
7	.1202	28	52	63	74	84	.1294	.1304	14
8	.1192	18	42	53	64	74	84	.1294	.1304
9	82	.1208	32	43	54	64	74	84	.1294
130	.1171	.1197	21	32	43	53	63	73	83
1	61	87	11	22	33	43	53	63	73

FACTORS OF EVAPORATION (SECTION 2).—*Continued.*

Lbs. Feed Water°	**80** 311.8°	**90** 320+°	**100** 327.6°	**105** 331.1°	**110** 334.52°	**115** 337.81°	**120** 341°	**125** 344.1°	**130** 347.1°
132	.1151	.1177	.1201	.1212	.1223	.1233	.1243	.1253	.1263
3	41	67	.1191	.1202	.1213	23	33	43	53
4	30	56	80	.1191	.1202	12	22	32	42
5	19	45	69	80	.1191	.1201	11	21	31
6	.1109	35	59	70	81	.1191	.1201	11	21
7	.1099	25	49	60	71	81	.1191	.1201	11
8	89	15	39	50	61	71	81	.1191	.1201
9	79	.1105	29	40	51	61	71	81	.1191
140	68	.1094	18	29	40	50	60	70	80
1	57	83	.1107	18	29	39	49	59	69
2	47	73	.1097	.1108	19	29	39	49	59
3	36	62	86	.1097	.1108	18	28	38	48
4	26	52	76	87	.1098	.1108	18	28	38
5	16	42	66	77	88	.1098	.1108	18	28
6	.1005	31	55	66	77	87	.1097	.1107	17
7	.0994	20	44	55	66	76	86	.1096	.1106
8	84	10	34	45	56	66	76	86	.1096
9	74	.1000	24	35	46	56	66	76	86
150	64	.0990	14	25	36	46	56	66	76
1	53	79	.1004	15	26	36	46	56	66
2	43	69	.0993	.1004	15	25	35	45	55
3	32	58	82	.0993	.1004	14	24	34	44
4	22	48	72	83	.0993	.1003	13	23	33
5	11	37	61	72	83	.0993	.1003	13	23
6	.0901	27	51	62	73	83	.0993	.1003	13
7	.0890	16	40	51	62	72	82	.0992	.1002
8	80	.0906	30	41	52	62	72	82	.0992
9	70	.0896	20	31	42	52	62	72	82
160	59	85	.0909	20	31	41	51	61	71
1	49	75	.0899	.0910	21	31	41	51	61
2	38	64	88	.0899	.0910	20	30	40	50
3	27	53	77	88	.0899	.0909	19	29	39
4	17	43	67	78	89	.0899	.0909	19	29
5	.0807	33	57	68	79	89	.0899	.0909	19
6	.0797	23	47	58	69	79	89	.0899	.0909
7	86	12	36	47	58	68	78	88	.0898
8	76	.0802	26	37	48	58	68	78	88
9	65	.0791	15	26	37	47	57	67	77
170	55	81	.0805	16	27	37	47	57	67
1	44	70	.0794	.0805	16	26	36	46	56
2	33	59	83	.0794	.0805	15	25	35	45
3	23	49	73	84	.0795	.0805	15	25	35
4	13	39	63	74	85	.0795	.0805	15	25
5	.0703	29	53	64	75	85	.0795	.0805	15
6	.0692	18	42	53	64	74	84	.0795	.0805
7	82	.0708	32	43	54	64	74	84	.0794
8	72	.0698	22	33	44	54	64	74	84
9	61	87	11	22	33	43	53	63	73
180	50	76	.0700	11	22	32	42	52	62
1	39	65	.0689	.0700	11	21	31	41	51
2	29	55	79	.0690	.0701	11	21	31	41
3	19	45	69	80	.0691	.0701	11	21	31

FACTORS OF EVAPORATION (SECTION 2).—*Continued.*

Lbs.	**80**	**90**	**100**	**105**	**110**	**115**	**120**	**125**	**130**
Feed Water°	311.8°	320+°	327.6°	331.1°	334.52°	337.81°	341°	344.1°	347.1°
184	.0609	.0635	.0759	.0670	.0680	.0691	.0701	.0711	.0721
5	.0598	.0624	.0648	.0659	.0669	.0680	.0691	.0700	.0709
6	88	14	38	49	60	70	80	.0690	.0700
7	78	.0604	28	39	50	60	70	80	.0690
8	67	.0593	17	28	39	49	59	69	79
9	57	83	.0607	18	29	39	49	59	69
190	46	72	.0596	.0607	18	28	38	48	58
1	36	62	86	.0597	.0608	18	28	38	48
2	25	51	75	86	.0597	.0607	17	27	37
3	15	41	65	76	87	.0597	.0607	17	27
4	.0505	31	55	66	77	87	.0597	.0607	17
5	.0494	20	44	55	66	76	86	.0596	.0606
6	83	.0509	33	44	55	65	75	85	.0595
7	72	.0498	22	33	44	54	64	74	84
8	62	88	12	23	34	44	54	64	74
9	52	78	.0502	13	24	34	44	54	64
200	41	67	.0491	.0502	13	23	33	43	53
1	31	57	81	.0492	.0503	13	23	33	43
2	21	47	71	82	.0493	.0503	13	23	33
3	11	37	61	72	83	.0493	.0503	13	23
4	.0401	27	51	62	73	83	.0493	.0503	13
5	.0390	16	40	51	62	72	82	.0492	.0502
6	79	.0405	29	40	51	61	71	81	.0491
7	68	.0394	18	29	40	50	60	70	80
8	57	83	.0407	18	29	39	49	59	69
9	46	72	.0396	.0407	18	28	38	48	58
210	.0336	62	86	.0397	.0408	18	28	38	48
1	25	51	75	86	.0397	.0407	17	27	37
2	.0315	.0341	.0365	.0376	.0387	.0397	.0407	.0417	.0427
K=	**.00026**	**.00024**	**.00022**	**.00022**	**.00020**	**.00020**	**.00020**	**.00020**	**.00018**

NOTE.—The figures at the foot of the page, at bottom of each column, are Constants for each pound of pressure between that column and the next one beyond it **only**, and for each or any degree from 32 to 212. If the exact Factor is wanted, add the decimal as many times as there is difference in pounds to the Factor from that column, and you have the precise factor of evaporation for **any** degree and every pound of the absolute pressure, from 15 lbs. absolute up to two hundred pounds. Example: wanted, the factor for 113 lbs. and 79° F. From 110 lbs. take 79° = 1.1774, then three times .00020 is .00060, and 1.1774 + .00060 = 1.1780, which is exact, and so for any pressure or degree. The line K is Constant for that line of pressure only (top of page), but for any degree of that line of pressure, from 32 to 212, and between the pressure in pounds (absolute) per square inch, over the K and the next column to the right. The last K on the page goes to the first column on the next page.

HEAT OF STEAM (REGNAULT'S, DIRECT FROM HIS OWN FIGURES). Author's Computation—Fahrenheit Degrees and British Thermal Units.

The first left-hand column is Temperature of the Steam in Fahrenheit degrees.
H. = Total Heat of the Steam, from 32° F.
L. = Latent Heat of Vaporization, from 32° F.
P. = Pounds per Square Inch at 45° Latitude, Sea Level, Mercury at 32° F. t.
h. = Heat of the Liquid, from 32° F.

NOTE.—The points marked with (×) are the points of Regnault's observations converted into Fahrenheit degrees, precise in every instance, and all computations are with the strictest regard to his own observations.

All F°	H.	L.	P.	h.
104×	1113.66	1041.66	1.0621	72.091
5	13.96	40.95	1.0939	73.095
6	14.26	40.24	1.1267+	74.099
7	14.56	39.53	1.1600	75.103
8	14.86	38.82	1.1948	76.106
9	15.16	38.11	1.2301	77.109
110	15.46	37.40	1.2665	78.113
1	15.76	36.69	1.3035	79.117
2	16.06	35.98	1.3418	80.121
3	16.36	35.27	1.3805	81.124
4	16.66	34.56	1.4207	82.128
5	16.96	33.85	1.4618	83.131
6	17.26	33.14	1.5040−	84.135
7	17.56	32.43	1.5470	85.139
8	17.86	31.72	1.5911+	86.142
9	18.16	31.01	1.6362	87.146
120	18.46	1030.30	1.6828−	88.149
1	18.76	29.59	1.7303−	89.153
2×	19.06	28.88	1.7788	90.156
3	19.37	28.19	1.8287	91.162
4	19.68	27.50	1.8797	92.167
5	19.99	26.81	1.9321	93.172
6	1120.30	26.12	1.9855	94.177
7	20.61	25.43	2.0399	95.182
8	20.92	24.74	2.0957	96.187
9	21.23	24.05	2.1530+	97.192
130	21.54	23.36	2.2118	98.197
1	21.85	22.67	2.2721	99.202
2	22.16	21.98	2.3333	100.207
3	22.47	21.29	2.3960	101.212
4	22.78	1020.60	2.4602	102.217
5	23.09	19.91	2.5258	103.222
6	23.40	19.22	2.5929	104.227
7	23.71	18.53	2.6620	105.232
8	24.02	17.84	2.7321	106.237
9	24.33	17.15	2.8041	107.242
140×	24.64	16.46	2.8775	108.246
1	24.94	15.75	2.9525	109.254
2	25.24	15.04	3.0289	110.261
3	25.54	14.33	3.1073	111.269

HEAT OF STEAM.—*Continued.*

All F°	H.	L.	P.	h.
144	1125.84	1013.62	3.1877	112.276
5	26.14	12.91	3.2695	113.283
6	26.44	12.20	3.3532	114.290
7	26.74	11.49	3.4385	115.298
8	27.04	10.78	3.5262	116.305
9	27.34	1010.07	3.6154	117.312
150	27.64	09.36	3.7065	118.320
1	27.94	08.65	3.7996	119.327
2	28.24	07.94	3.8940	120.334
3	28.54	07.23	3.9911	121.342
4	1128.84	06.52	4.0900	122.349
5	29.14	05.81	4.1914	123.356
6	29.44	05.10	4.2948	124.363
7	29.74	04.39	4.4001	125.371
8 ×	1130.04	03.68	4.5074	126.378
9	30.35	02.98	4.6171	127.385
160	30.66	02.28	4.7293	128.392
1	30.97	01.58	4.8434	129.400
2	31.28	00.88	4.9601	130.407
3	31.59	1000.18	5.0791	131.414
4	31.90	999.48	5.2006	132.421
5	32.21	98.78	5.3240	133.428
6	32.52	98.08	5.4504	134.436
7	32.83	97.38	5.5793	135.443
8	33.14	96.68	5.7106	136.450
9	33.45	95.98	5.8443	137.457
170	33.76	95.28	5.9810	138.464
1	34.07	94.58	6.1201	139.472
2	34.38	93.88	6.2622	140.479
3	34.69	93.18	6.4067	141.486
4	35.00	92.48	6.5541	142.493
5	35.31	91.78	6.7046	143.500
6 ×	35.62	91.08	6.8574	144.508
7	35.92	990.37	7.0136	145.518
8	36.22	989.66	7.1728	146.528
9	36.52	88.95	7.3350	147.538
180	36.82	88.24	7.5002	148.548
1	37.12	87.53	7.6682	149.558
2	37.42	86.82	7.8395	150.567
3	37.72	86.11	8.0144	151.577
4	38.02	85.40	8.1922	152.587
5	38.32	84.69	8.3735+	153.597
6	38.62	83.98	8.5578	154.607
7	38.92	83.27	8.7459	155.617
8	39.22	82.56	8.9370	156.627
9	39.52	81.85	9.1319	157.637
190	39.82	81.14	9.3302	158.647
1	1140.12	980.43	9.5322	159.657
2	40.42	979.72	9.7378	160.666
3	40.72	79.01	9.9470	161.676
4 ×	41.02	78.30	10.1602	162.685
5	41.33	77.60	10.3770	163.698
6	41.64	76.90	10.5964	164.710

HEAT OF STEAM.—*Continued.*

All F°	H.	L.	P.	h.
197	1141.95	976.20	10.8220	165.722
8	42.26	75.50	11.0502	166.733
9	42.57	74.80	11.2830	167.745
200	42.88	74.10	11.5197	168.757
1	43.19	73.40	11.7600	169.769
2	43.50	72.70	12.0050	170.781
3	43.81	72.00	12.2540	171.793
4	1144.12	71.30	12.5075	172.805
5	44.43	970.60	12.7652	173.817
6	44.74	69.90	13.0275	174.829
7	45.05	69.20	13.2940	175.841
8	45.36	68.50	13.5654	176.852
9	45.67	67.80	13.8410	177.864
210	45.98	67.10	14.1210	178.876
1	46.29	66.40	14.4066	179.888
2×	46.60	65.70	14.69636	180.900
3	46.90	64.89	14.9903	181.914
4	47.20	64.28	15.2900	182.928
5	47.50	63.57	15.5930	183.942
6	47.80	62.86	15.9015+	184.956
7	48.10	62.15	16.2200	185.971
8	48.40	61.44	16.5383	186.985
9	48.70	60.73	16.8616	187.999
220	49.00	960.02	17.1900−	189.013
1	49.30	959.31	17.5280	190.027
2	49.60	58.60	17.8660	191.041
3	49.90	57.89	18.2140−	192.055
4	50.20	57.18	18.5665	193.069
5	50.50	56.47	18.9240	194.083
6	50.80	55.76	19.2867	195.097
7	51.10	55.05	19.6540	196.112
8	51.40	54.34	20.0262	197.126
9	51.70	53.63	20.4085	198.140
230×	52.00	52.92	20.7955	199.154
1	52.31	52.21	21.1875+	200.170
2	52.62	51.50	21.5840	201.187
3	52.93	50.79	21.9908	202.203
4	53.24	950.08	22.3975	203.220
5	53.55	949.37	22.8140	204.236
6	53.86	48.66	23.2397	205.253
7	54.17	47.95	23.6663	206.269
8	54.48	47.24	24.1023	207.286
9	54.79	46.53	24.5471	208.302
240	55.10	45.82	24.9935	209.319
1	55.41	45.11	25.4495	210.335
2	55.72	44.40	25.9150	211.352
3	56.03	43.69	26.3852	212.368
4	56.34	42.98	26.8603	213.385
5	56.65	42.27	27.3451	214.401
6	56.96	41.56	27.8350	215.418
7	57.27	40.85	28.3300−	216.434
8×	57.58	940.14	28.8390	217.451
9	57.88	939.42	29.3488	218.470

HEAT OF STEAM.—*Continued.*

All F°	H.	L.	P.	h.
250	1158.18	938.70	29.8683	219.489
1	58.48	37.98	30.3970	220.508
2	58.78	37.26	.30.9310−	221.527
3	59.08	36.54	31.4746	222.546
4	59.38	35.82	32.0236	223.565
5	59.68	35.10	32.5822	224.585
6	59.98	34.38	33..452	225.604
7	60.28	33.66	33.7238	226.623
8	60.58	32.94	34.3013	227.642
9	60.88	32.22	34.8940−	228.661
260	61.18	31.50	35.4920−	229.680
1	61.48	30.78	36.0994	230.699
2	61.78	930.06	36.7113	231.718
3	62.08	929.34	37.3388	232.737
4	62.38	28.62	37.9710−	233.756
5	62.68	27.90	38.6073+	234.776
6×	62.98	27.18	39.2590+	235.795
7	63.29	26.47	39.9153	236.816
8	63.60	25.76	40.5863	237.838
9	63.91	25.05	41.2630	238.860
270	64.24	24.34	41.9490−	239.882
1	64.55	23.63	42.6390−	240.904
2	64.86	22.92	43.3451	241.925
3	65.17	22.21	44.0596	242.947
4	65.48	21.50	44.7796	243.969
5	65.79	20.79	45.5145+	244.991
6	66.10	920.08	46.2541	246.013
7	66.41	919.37	47.0090−	247.034
8	66.72	18.66	47.7683	248.056
9	67.03	17.95	48.5422+	249.078
280	67.31	17.24	49.3210−	250.100
1	67.62	16.53	50.1153	251.122
2	67.93	15.82	50.9132−	252.143
3	68.24	15.11	51.7262−	253.165
4×	68.56	14.40	52.5497	254.187
5	68.86	13.67	53.3826	255.212
6	69.16	12.94	54.2251−	256.236
7	69.46	12.21	55.0820+	257.261
8	69.76	11.48	55.9448+	258.286
9	70.06	10.75	56.8212−	259.311
290	70.36	910.02	57.7085+	260.335
1	70.66	909.29	58.6098	261.360
2	70.96	08.56	59.5165	262.385
3	71.26	07.83	60.4366	263.409
4	71.56	07.10	61.3677+	264.434
5	71.86	06.37	62.3132	265.459
6	72.16	05.64	63.2674	266.483
7	72.46	04.91	64.2332	267.508
8	72.76	04.18	65.2124	268.533
9	73.06	03.45	66.2028	269.558
300	73.36	02.72	67.2063	270.582
1	73.66	01.99	68.2213	271.607
2×	73.960	01.26	69.2500	272.632

HEAT OF STEAM.—*Continued.*

All F°	H.	L.	P.	h.
303	1174.27	900.55	70.2878	273.660
4	74.58	899.84	71.3411	274.687
5	74.89	99.13	72.4036	275.715
6	75.20	98.42	73.2320	276.743
7	75.51	97.71	74.5693	277.771
8	75.82	97.00	75.6711	278.799
9	76.13	96.29	76.7892	279.827
310	76.44	95.58	77.9148	280.855
1	76.75	94.87	79.0570—	281.883
2	77.06	94.16	80.2121	282.911
3	77.37	93.45	81.3842	283.939
4	77.68	92.74	82.5639	284.966
5	77.99	92.03	83.7607	285.994
6	78.30	91.32	84.9690	287.022
7	78.61	890.61	86.1946	288.050
8	78.92	889.90	87.4300—	289.078
9	79.23	89.19	88.6790—	290.106
320×	79.54	88.48	89.9477	291.134
1	79.84	87.74	91.2263	292.165
2	80.14	87.00	92.5188	293.196
3	80.44	86.26	93.8275	294.227
4	80.74	85.52	95.1503	295.258
5	81.04	84.78	96.4873	296.289
6	81.34	84.64	97.8431	297.320
7	81.64	83.30	99.2110—	298.351
8	81.94	82.56	100.5912	299.383
9	82.24	81.82	101.9934	300.414
330	82.54	81.08	103.4047	301.445
1	82.84	880.34	104.8335	302.476
2	83.14	879.60	106.2794	303.507
3	83.44	78.86	107.7383	304.538
4	83.74	78.12	109.2144	305.569
5	84.04	77.38	110.7032	306.600
6	84.34	76.64	112.2122	307.631
7	84.64	75.90	113.7366	308.662
8×	84.94	75.160	115.2790	309.694
9	85.25	74.466	116.8342	310.728
340	85.56	73.768	118.4050	311.763
1	85.87	73.070	119.9969	312.797
2	86.18	72.372	121.6020	313.832
3	86.49	71.674	123.2253	314.867
4	86.80	70.976	124.8648	315.901
5	87.11	870.278	126.5200	316.936
6	87.42	869.580	128.1980	317.970
7	87.73	68.882	129.8910	319.005
8	88.04	68.184	131.6013	320.040
9	88.35	67.486	133.3245	321.074
350	88.66	66.788	135.0704	322.109
1	88.97	66.090	136.8328	323.143
2	89.28	65.392	138.6180	324.178
3	89.59	64.694	140.4134	325.213
4	1189.90	63.996	142.2328	326.247
5	90.21	63.298	144.0660	327.282

HEAT OF STEAM.—*Continued.*

All F°	H.	L.	P.	h.
356×	1190.52	862.600	145.9217	328.316
7	90.82	61.832	147.7920	329.355
8	91.12	61.072	149.6822	330.393
9	91.42	60.310	151.5930	331.431
360	91.72	59.548	153.5190	332.469
1	92.02	58.786	155.4621	333.507
2	92.32	58.024	157.4382	334.545
3	92.62	57.262	159.4226	335.583
4	92.92	56.500	161.4321	336.621
5	93.22	55.738	163.4520	337.659
6	93.52	54.976	165.4970	338.697
7	93.82	54.214	167.5637	339.736
8	94.12	53.452	169.6524	340.774
9	94.42	52.690	171.7510	341.812
370	94.72	51.928	173.8762	342.850
1	95.02	51.166	176.0233	343.888
2	95.32	50.404	178.1900—	344.926
3	95.62	49.642	180.3808	345.964
4×	95.92	48.880	182.5828	347.002
5	96.23	48.150	184.8120	348.044
6	96.54	47 420	187.0638	349.086
7	96.85	46.690	189.3347	350.129
8	97.16	45.960	191.6283	351.171
9	97.47	45.230	193.9367	352.213
380	97.78	44.500	196.2773	353.255
1	98.09	43.770	198.6324	354.297
2	98.40	43.040	201.0164	355.339
3	98.71	42.310	203.4089	356.381
4	99.02	41.580	205.8400	357.423
5	99.33	40.850	208.2764	358.465
6	99.64	40.120	210.7415	359.507
7	1199.95	39.390	213.2308	360.550
8	1200.26	38.660	215.7446	361.592
9	00.57	37.930	218.2800—	362.634
390	00.88	37.200	220.8310	363.676
1	01.19	36.470	223.4138	364.718
2×	1201.50	35.740	226.0217	365.760
3	01.80	34.990	228.6500—	366.806
4	02.10	34.240	231.2970	367.852
5	02.40	33.490	233.9646	368.898
6	02.70	32.740	236.6628	369.944
7	03.00	31.990	239.3812	370.990
8	03.30	31.240	242.1308	372.036
9	03.60	30.490	244.9007	373.082
400	03.90	29.740	247.6910—	374.128
1	04.20	28.990	250.5129	375.174
2	04.50	28.240	253.3378	376.220
3	04.80	27.490	256.2183	377.266
4	05.10	26.740	259.1130	378.312
5	05.40	25.990	262.0300—	379.358
6	05.70	25.240	264.9659	380.404
7	06.00	24.490	267.9353	381.450
8	06.30	23.740	270.9256	382.496

HEAT OF STEAM.—*Concluded.*

All F°	H.	L.	P.	h.
409	1206.60	822.990	273.9429	383.542
410×	06.90	22.240	276.9810	384.588
1	07.21	21.500	280.0529	385.638
2	07.52	20.760	283.1456	386.688
3	07.83	820.020	286.2662	387.739
4	08.14	819.280	289.4143	388.789
5	08.45	18.540	292.5837	389.839
6	08.76	17.800	295.7808	390.889
7	09.07	17.600	299.0060	391.939
8	09.38	16.320	302.2526	392.990
9	1209.69	15.580	305.5344	394.040
420	1210.00	14.840	308.8374	395.090
1	10.31	14.100	312.1692	396.140
2	10.62	13.360	315.5298	397.190
3	10.93	12.620	318.9188	398.241
4	11.24	11.880	322.3300	399.291
5	11.55	11.140	325 7693	400.341
6	11.86	810.400	329.2380	401.391
7	12.17	809.660	332.7362	402.441
8×	12.48	08.920	336.2600	403.492
9	12.78	08.170	339.8130	404.547
430	13.08	07.420	343.3919	405.601
1	13.38	06.670	347.0005	406.656
2	13.68	05.920	350.6470	407.710
3	13.98	05.170	....	408.765
4	14.28	04.420	....	409.820
5	14.58	03.670	....	410.874
6	14.88	02.920	....	411.929
7	15.18	02.170	....	412.983
8	15.48	01.420	....	414.038
9	15.78	800.670	....	415.093
440	16.08	799.920	....	416.147
1	16.38	99.170	....	417.202
2	16.68	98.420	....	418.256
3	16.98	97.670	....	419.311
4	17.28	96.920	....	420.366
5	17.58	96.170	....	421.420
6×	1217.88	795.420	....	422.474

NOTE.—The plus and minus signs in column P signify that the last figure is either slightly above or below the exact fact, too small for any use except computation of constants.

STEAM TABLE FOR EACH FAHRENHEIT DEGREE, 104 TO 432.

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude and Sea Level.
104	2.168	0.33606	2.1623	0.33491	1.0621	0.02615
5	2.233	0.34889	2.2271	0.34774	1.0939	0.03898
6	2.300	0.36173	2.2939	0.36058	1.1267+	0.05182
7	2.368	0.37438	2.3617	0.37323	1.1600	0.06447
8	2.439	0.38721	2.4326	0.38606	1.1948	0.07730
9	2.511	0.39985	2.5044	0.39870	1.2301	0.08994
110	2.585	0.41246	2.5782	0.41137	1.2665	0.10261
1	2.661	0.42504	2.6539	0.42389	1.3035	0.11513
2	2.739	0.43759	2.7318	0.43644	1.3418	0.12768
3	2.818	0.44994	2.8106	0.44879	1.3805	0.14003
4	2.900	0.46240	2.8924	0.46125	1.4207	0.15249
5	2.984	0.47480	2.9761	0.47365	1.4618	0.16489
6	3.070	0.48714	3.0619	0.48599	1.5040−	0.17723
7	3.158	0.49941	3.1496	0.49826	1.5470	0.18950
8	3.248	0.51162	3.2395	0.51047	1.5911+	0.20171
9	3.340	0.52375	3.3312	0.52260	1.6362	0.21384
120	3.435	0.53593	3.4260	0.53478	1.6828−	0.22602
1	3.532	0.54802	3.5227	0.54687	1.7303−	0.23811
2	3.631	0.56003	3.6215	0.55888	1.7788	0.25012
3	3.733	0.57206	3.7232	0.57091	1.8287	0.26215
4	3.837	0.58399	3.8268	0.58284	1.8797	0.27408
5	3.944	0.59594	3.9336	0.59479	1.9321	0.28603
6	4.053	0.60778	4.0423	0.60663	1.9855	0.29787
7	4.164	0.61951	4.1530	0.61836	2.0399	0.30960
8	4.278	0.63124	4.2667	0.63009	2.0957	0.32133
9	4.395	0.64296	4.3834	0.64181	2.1530+	0.33305
130	4.515	0.65466	4.5031	0.65351	2.2118	0.34475
1	4.638	0.66633	4.6257	0.66518	2.2721	0.35642
2	4.763	0.67788	4.7504	0.67673	2.3333	0.36797
3	4.891	0.68940	4.8781	0.68825	2.3960	0.37949
4	5.022	0.70088	5.0088	0.69973	2.4602	0.39097
5	5.156	0.71231	5.1423	0.71116	2.5258	0.40240
6	5.293	0.72370	5.2790	0.72255	2.5929	0.41379
7	5.434	0.73512	5.4196	0.73397	2.6620	0.42521
8	5.577	0.74640	5.5623	0.74525	2.7321	0.43649
9	5.724	0.75770	5.7089	0.75655	2.8041	0.44779
140	5.874	0.76893	5.8584	0.76778	2.8775	0.45902
1	6.027	0.78010	6.0111	0.77895	2.9525	0.47019
2	6.183	0.79120	6.1667	0.79005	3.0289	0.48129
3	6.343	0.80229	6.3262	0.80114	3.1073	0.49238
4	6.507	0.81338	6.4898	0.81223	3.1877	0.50347
5	6.674	0.82439	6.6564	0.82324	3.2695	0.51448
6	6.845	0.83537	6.8269	0.83422	3.3532	0.52546
7	7.019	0.84628	7.0005	0.84513	3.4385	0.53637
8	7.198	0.85721	7.1789	0.85606	3.5262	0.54730
9	7.380	0.86806	7.3606	0.86691	3.6154	0.55815

STEAM TABLE —*Continued.*

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° l atitude and Sea Level.
150	7.566	0.87887	7.5461	0.87772	3.7065	0.56896
1	7.756	0.88964	7.7356	0.88849	3.7996	0.57973
2	7.949	0.90031	7.9280	0.89916	3.8940	0.59040
3	8.147	0.91100	8.1255	0.90985	3.9911	0.60109
4	8.349	0.92163	8.3269	0.92048	4.0900	0.61172
5	8.556	0.93227	8.5334	0.93112	4.1914	0.62236
6	8.767	0.94285	8.7438	0.94170	4.2948	0.62294
7	8.982	0.95337	8.9582	0.95222	4.4001	0.64346
8	9.201	0.96384	9.1768	0.96269	4.5074	0.65393
9	9.425	0.97428	9.4001	0.97313	4.6171	0.66437
160	9.654	0.98471	9.6286	0.98356	4.7293	0.67480
1	9.887	0.99506	9.8608	0.99391	4.8434	0.68515
2	10.125	1.00540	10.0983	1.00425	4.9601	0.69549
3	10.368	1.01570	10.3408	1.01455	5.0791	0.70579
4	10.616	1.02596	10.5880	1.02481	5.2006	0.71605
5	10.868	1.03615	10.8400	1.03500	5.3240	0.72624
6	11.126	1.04634	11.0960	1.04519	5.4504	0.73643
7	11.389	1.05649	11.3590	1.05534	5.5793	0.74658
8	11.657	1.06659	11.6263	1.06544	5.7106	0.75668
9	11.930	1.07664	11.8982	1.07549	5.8443	0.76673
170	12.209	1.08668	12.1768	1.08553	5.9810	0.77677
1	12.493	1.09667	12.4600	1.09552	6.1201	0.78676
2	12.783	1.10663	12.7491	1.10548	6.2622	0.79672
3	13.078	1.11654	13.0434	1.11539	6.4067	0.80663
4	13.379	1.12642	13.3435	1.12527	6.5541	0.81651
5	13.686	1.13628	13.6500	1.13513	6.7046	0.82637
6	13.998	1.14607	13.9610	1.14492	6.8574	0.83616
7	14.317	1.15585	14.2791	1.15470	7.0136	0.84594
8	14.642	1.16560	14.6033	1.16445	7.1728	0.85569
9	14.973	1.17531	14.9334	1.17416	7.3350	0.86540
180	15.310	1.18498	15.2700	1.18383	7.5002	0.87507
1	15.653	1.19460	15.6120	1.19345	7.6682	0.88469
2	16.003	1.20420	15.9606	1.20305	7.8395	0.89429
3	16.360	1.21378	16.3166	1.21263	8.0144	0.90387
4	16.723	1.22331	16.6786	1.22216	8.1922	0.91340
5	17.093	1.23282	17.0480	1.23167	8.3735+	0.92291
6	17.469	1.24227	17.4230	1.24112	8.5578	0.93236
7	17.853	1.25171	17.8059	1.25056	8.7459	0.94180
8	18.243	1.26110	18.1950	1.25995	8.9370	0.95119
9	18.641	1.27047	18.5919	1.26932	9.1319	0.96056
190	19.046	1.27980	18.9954	1.27865	9.3302	0.96989
1	19.458	1.28910	19.4066	1.28795	9.5322	0.97919
2	19.878	1.29837	19.8253	1.29722	9.7378	0.98846
3	20.305	1.30760	20.2512	1.30645	9.9470	0.99769
4	20.740	1.31681	20.6852	1.31566	10.1602	1.00690
5	21.182	1.32597	21.1261	1.32482	10.3770	1.01606
6	21.632	1.33510	21.5750	1.33395	10.5964	1.02516
7	22.091	1.34422	22.0330	1.34307	10.8220	1.03431
8	22.557	1.35328	22.4973	1.35213	11.0502	1.04337
9	23.032	1.36233	22.9710	1.36118	11.2830	1.05242

STEAM TABLE.—*Continued.*

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude and Sea Level.
200	23.515	1.37135	23.4530	1.37020	11.5197	1.06144
1	24.006	1.38032	23.9425	1.37917	11.7600	1.07041
2	24.506	1.38927	24.4410	1.38812	12.0050	1.07936
3	25.014	1.39818	24.9400	1.39703	12.2540	1.08827
4	25.532	1.40708	25.4642	1.40593	12.5075	1.09717
5	26.058	1.41594	25.9890	1.41479	12.7652	1.10603
6	26.593	1.42477	26.5228	1.42362	13.0275	1.11486
7	27.137	1.43356	27.0651	1.43241	13.2940	1.12365
8	27.691	1.44234	27.6180	1.44119	13.5654	1.13243
9	28.254	1.45108	28.1790	1.44993	13.8410	1.14117
210	28.826	1.45978	28.7494	1.45863	14.1210	1.14987
11	29.408	1.46847	29.3305	1.46732	14.4066	1.15856
12	30.000	1.47712	29.9206	1.47597	14.69636	1.16721
13	30.600	1.48572	30.5190	1.48457	14.9903	1.17581
14	31.210	1.49431	31.1286	1.49316	15.2900	1.18440
15	31.830	1.50284	31.7460	1.50169	15.5930	1.19293
16	32.460	1.51135	32.3743	1.51020	15.9015+	1.20144
17	33.110	1.51996	33.0225	1.51881	16.2200	1.21005
18	33.760	1.52840	33.6705	1.52725	16.5383	1.21849
19	34.420	1.53681	34.3290	1.53566	16.8616	1.22690
220	35.090	1.54518	34.9970	1.54403	17.1900—	1.23527
1	35.780	1.55364	35.6853	1.55249	17.5280	1.24373
2	36.470	1.56194	36.3740	1.56079	17.8660	1.25203
3	37.180	1.57031	37.0820	1.56916	18.2140—	1.26040
4	37.900	1.57864	37.8000	1.57749	18.5665	1.26873
5	38.630	1.58692	38.5270	1.58577	18.9240	1.27701
6	39.370	1.59517	39.2663	1.59402	19.2867	1.28526
7	40.120	1.60336	40.0140	1.60221	19.6540	1.29345
8	40.880	1.61151	40.7720	1.61036	20.0262	1.30160
9	41.660	1.61972	41.5500	1.61857	20.4085	1.30981
230	42.450	1.62788	42.3380	1.62673	20.7955	1.31797
1	43.250	1.63599	43.1360	1.63484	21.1875+	1.32608
2	44.060	1.64404	43.9430	1.64289	21.5840	1.33413
3	44.890	1.65215	44.7713	1.65100	21.9908	1.34224
4	45.720	1.66011	47.5995	1.65896	22.3975	1.35020
5	46.570	1.66811	46.4473	1.66696	22.8140	1.35820
6	47.440	1.67614	47.3140	1.67499	23.2397	1.36623
7	48.310	1.68404	48.1830	1.68289	23.6663	1.37413
8	49.200	1.69197	49.0704	1.69082	24.1023	1.38206
9	50.110	1.69992	49.9770	1.69877	24.5471	1.39001
240	51.020	1.70774	50.8850	1.70659	24.9935	1.39783
1	51.950	1.71559	51.8132	1.71444	25.4495	1.40568
2	52.900	1.72346	52.7610	1.72231	25.9150	1.41355
3	53.860	1.73127	53.7180	1.73012	26.3852	1.42136
4	54.830	1.73902	54.6852	1.73787	26.8603	1 42911
5	55.820	1.74679	55.6724	1.74564	27.3451	1.43688
6	56.820	1.75450	56.6700	1.75335	27.8350	1.44459
7	57.830	1.76215	57.6770	1.76100	28.3300—	1.45224
8	58.870	1.76989	58.7140	1.76874	28.8390	1.45998
9	59.910	1.77750	59.7520	1.77635	29.3488	1.46759

STEAM TABLE.—*Continued.*

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude and Sea Level.
250	60.970	1.78512	60.8094	1.78397	29.8683	1.47521
1	62.050	1.79274	61.8860	1.79159	30.3970	1.48283
2	63.140	1.80030	62.9730	1.79915	30.9310—	1.49039
3	64.250	1.80787	64.0796	1.80672	31.4746	1.49796
4	65.370	1.81538	65.1974	1.81423	32.0236	1.50547
5	66.510	1.82289	66.3346	1.82174	32.5822	1.51298
6	67.660	1.83033	67.4810	1.82918	33.1452	1.52042
7	68.840	1.83784	68.6580	1.83669	33.7238	1.52793
8	70.020	1.84522	69.8345	1.84407	34.3013	1.53531
9	71.230	1.85266	71.0412	1.85151	34.8940—	1.54275
260	72.450	1.86004	72.2590	1.85889	35.4920—	1.55013
1	73.690	1.86741	73.4954	1.86626	36.0994	1.55750
2	74.940	1.87471	74.7412	1.87356	36.7113	1.56480
3	76.220	1.88207	76.0186	1.88092	37.3388	1.57216
4	77.510	1.88936	77.3054	1.88821	37.9710—	1.57945
5	78.810	1.89658	78.6014	1.89543	38.6073+	1.58667
6	80.140	1.90385	79.9290	1.90270	39.2590+	1.59394
7	81.480	1.91105	81.2643	1.90990	39.9153	1.60114
8	82.850	1.91829	82.6304	1.91714	40.5863	1.60838
9	84.230	1.92547	84.0079	1.92432	41.2630	1.61556
270	85.630	1.93263	85.4044	1.93148	41.9490—	1.62272
1	87.040	1.93972	86.8101	1.93857	42.6390—	1.62981
2	88.480	1.94685	88.2470	1.94570	43.3451	1.63694
3	89.940	1.95395	89.7016	1.95280	44.0596	1.64404
4	91.410	1.96099	91.1675	1.95984	44.7796	1.65108
5	92.910	1.96806	92.6638	1.96691	45.5145+	1.65815
6	94.420	1.97506	94.1695	1.97391	46.2541	1.66515
7	95.960	1.98209	95.7062	1.98094	47.0090—	1.67218
8	97.510	1.98905	97.2523	1.98790	47.7683	1.67914
9	99.090	1.99603	98.8280	1.99488	48.5422+	1.68612
280	100.680	2.00294	100.4130	2.00179	49.3210—	1.69303
1	102.30	2.00988	102.0305	2.00873	50.1153	1.69997
2	103.93	2.01674	103.6550	2.01559	50.9132—	1.70683
3	105.59	2.02362	105.3101	2.02247	51.7262—	1.71371
4	107.27	2.03048	106.9860	2.02933	52.5497	1.72057
5	108.97	2.03731	108.6853	2.03616	53.3826	1.72740
6	110.69	2.04411	110.3976	2.04296	54.2251—	1.73420
7	112.44	2.05092	112.1425	2.04977	55.0820+	1.74101
8	114.20	2.05767	113.9000	2.05652	55.9448+	1.74776
9	115.99	2.06442	115.6832	2.06327	56.8212—	1.75451
290	117.80	2.07115	117.4900	2.07000	57.7085+	1.76124
1	119.64	2.07788	119.3246	2.07673	58.6098	1.76797
2	121.49	2.08454	121 1686	2.08339	59.5165	1.77463
3	123.37	2.09121	123.0438	2.09006	60.4366	1.78130
4	125.27	2.09785	124.9400	2.09670	61.3677+	1.78794
5	127.20	2.10449	126.8646	2.10334	62.3132	1.79458
6	129.15	2.11109	128.8072	2.10994	63.2674	1.80118
7	131.12	2.11767	130.7740	2.11652	64.2332	1.80776
8	133.12	2.12424	132.7670	2.12309	65.2124	1.81433
9	135.14	2.13078	134.7810	2.12963	66.2028	1.82087

STEAM TABLE.—*Continued.*

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude and Sea Level.
300	137.19	2.13732	136.8296	2.13617	67.2063	1.82741
1	139.26	2.14383	138.8930	2.14268	68.2213	1.83392
2	141.36	2.15033	140.9873	2.14918	69.2500	1.84042
3	143.48	2.15679	143.1000	2.15564	70.2878	1.84688
4	145.63	2.16325	145.2446	2.16210	71.3411	1.85334
5	147.80	2.16967	147.4076	2.16852	72.4036	1.85976
6	149.49	2.17461	149.0590	2.17346	73.2320	1.86470
7	152.22	2.18247	151.8145	2.18132	74.5693	1.87256
8	154.47	2.18884	154.0600	2.18769	75.6711	1.87893
9	156.75	2.19521	156.3364	2.19406	76.7892	1.88530
310	159.05	2.20153	158.6280	2.20038	77.9148	1.89162
1	161.38	2.20785	160.9534	2.20670	79.0570—	1.89794
2	163.74	2.21415	163.3052	2.21300	80.2121	1.90424
3	166.13	2.22045	165.6915	2.21930	81.3842	1.91054
4	168.54	2.22670	168.0933	2.22555	82.5639	1.91679
5	170.98	2.23295	170.5300	2.23180	83.7607	1.92304
6	173.45	2.23917	172.9900	2.23802	84.9690	1.92926
7	175.95	2.24539	175.4850	2.24424	86.1946	1.93548
8	178.47	2.25157	178.0000	2.25042	87.4300—	1.94166
9	181.02	2.25773	180.5428	2.25658	88.6790—	1.94782
320	183.61	2.26390	183.1261	2.26275	89.9477	1.95399
1	186.22	2.27003	185.7300	2.26888	91.2263	1.96012
2	188.86	2.27614	188.3604	2.27499	92.5188	1.96623
3	191.53	2.28224	191.0248	2.28109	93.8275	1.97233
4	194.23	2.28832	193.7180	2.28717	95.1503	1.97841
5	196.96	2.29438	196.4400	2.29323	96.4873	1.98447
6	199.73	2.30044	199.2000	2.29929	97.8431	1.99053
7	202.52	2.30647	201.9854	2.30532	99.2110—	1.99656
8	205.34	2.31247	204.7953	2.31132	100.5912	2.00256
9	208.20	2.31848	207.6500	2.31733	101.9934	2.00857
330	211.08	2.32445	210.5233	2.32330	103.4047	2.01454
1	214.00	2.33041	213.4323	2.32926	104.8335	2.02050
2	216.95	2.33636	216.3765	2.33521	106.2794	2.02645
3	219.93	2.34228	219.3462	2.34113	107.7383	2.03237
4	222.94	2.34819	222.3514	2.34704	109.2144	2.03828
5	225.98	2.35407	225.3825	2.35292	110.7032	2.04416
6	229.06	2.35995	228.4547	2.35880	112.2122	2.05004
7	232.17	2.36581	231.5582	2.36466	113.7366	2.05590
8	235.32	2.37166	234.6983	2.37051	115.2790	2.06175
9	238.49	2.37747	237.8600	2.37632	116.8342	2.06756
340	241.70	2.38328	241.0627	2.38213	118.4050	2.07337
1	244.95	2.38908	244.3037	2.38793	119.9969	2.07917
2	248.23	2.39485	247.5710	2.39370	121.6020	2.08494
3	251.54	2.40061	250.8765	2.39946	123.2253	2.09070
4	254.89	2.40635	254.2142	2.40520	124.8648	2.09644
5	258.27	2.41207	257.5842	2.41092	126.5200	2.10216
6	261.69	2.41779	261.0000	2.41664	128.1980	2.10788
7	265.15	2.42349	264.4500	2.42234	129.8910	2.11358
8	268.64	2.42917	267.9300	2.42802	131.6013	2.11926
9	272.16	2.43482	271.4376	2.43367	133.3245	2.12491

STEAM TABLE.—*Continued.*

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude and Sea Level.
350	275.72	2.44047	274.9900	2.43932	135.0704	2.13056
1	279.32	2.44610	278.5800	2.44495	136.8328	2.13619
2	282.96	2.45173	282.2150	2.45058	138.6180	2.14182
3	286.63	2.45732	285.8710	2.45617	140.4134	2.14741
4	290.34	2.46291	289.5742	2.46176	142.2328	2.15300
5	294.08	2.46847	293.3054	2.46732	144.0660	2.15856
6	297.87	2.47403	297.0845	2.47288	145.9217	2.16412
7	301.69	2.47956	300.8916	2.47841	147.7920	2.16965
8	305.55	2.48508	304.7404	2.48393	149.6822	2.17517
9	309.45	2.49059	308.6314	2.48944	151.5930	2.18068
360	313.38	2.49607	312.5500	2.49492	153.5190	2.18616
1	317.36	2.50155	316.5200	2.50040	155.4621	2.19164
2	321.38	2.50702	320.5310	2.50587	157.4382	2.19711
3	325.43	2.51246	324.5710	2.51131	159.4226	2.20255
4	329.53	2.51790	328.6624	2.51675	161.4321	2.20799
5	333.66	2.52330	332.7745	2.52215	163.4520	2.21339
6	337.83	2.52870	336.9381	2.52755	165.4970	2.21879
7	342.05	2.53409	341.1458	2.53294	167.5637	2.22418
8	346.31	2.53947	345.3981	2.53832	169.6524	2.22956
9	350.60	2.54481	349.6714	2.54366	171.7510	2.23490
370	354.94	2.55015	353.9975	2.54900	173.8762	2.24024
1	359.32	2.55548	358.3700	2.55433	176.0233	2.24557
2	363.74	2.56079	362.7773	2.55964	178.1900—	2.25088
3	368.21	2.56610	367.2400	2.56495	180.3808	2.25619
4	372.71	2.57137	371.7235	2.57022	182.5828	2.26146
5	377.26	2.57664	376.2618	2.57549	184.8120	2.26673
6	381.86	2.58190	380.8465	2.58075	187.0638	2.27199
7	386.49	2.58714	385.4700	2.58599	189.3347	2.27723
8	391.17	2.59237	390.1400	2.59122	191.6283	2.28246
9	395.89	2.59757	394.8400	2.59642	193.9367	2.28766
380	400.66	2.60278	399.6000	2.60163	196.2773	2.29287
1	405.47	2.60796	404.4000	2.60681	198.6324	2.29805
2	410.32	2.61312	409.2324	2.61197	201.0164	2.30321
3	415.22	2.61828	414.1230	2.61713	203.4089	2.30837
4	420.17	2.62344	419.0735	2.62229	205.8400	2.31353
5	425.16	2.62855	424.0330	2.62740	208.2764	2.31864
6	430.19	2.63366	429.0520	2.63251	210.7415	2.32375
7	435.27	2.63876	434.1200	2.63761	213.2308	2.32885
8	440.40	2.64385	439.2371	2.64270	215.7446	2.33394
9	445.57	2.64892	444.3958	2.64777	218.2800—	2.33901
390	450.79	2.65397	449.5933	2.65282	220.8310	2.34406
1	456.06	2.65902	454.8520	2.65787	223.4138	2.34911
2	461.38	2.66406	460.1612	2.66291	226.0217	2.35415
3	466.74	2.66908	465.5110	2.66793	228.6500—	2.35917
4	472.15	2.67408	470.9010	2.67293	231.2970	2.36417
5	477.60	2.67906	476.3320	2.67791	233.9646	2.36915
6	483.11	2.68404	481.8250	2.68289	236.6628	2.37413
7	488.66	2.68900	487.3600	2.68785	239.3812	2.37909
8	494.27	2.69396	492.9580	2.69281	242.1308	2.38405
9	499.92	2.69890	498.5973	2.69775	244.9007	2.38899

STEAM TABLE—*Concluded.*

Temperature of the Steam F°.	Inches of Mercury at Equator at 32° F. and Sea Level.	Log. inches of Mercury at 0° Latitude.	Inches of Mercury at Latitude 45°, Sea Level t. 32°.	Log. inches of Mercury at 45° Latitude.	Equivalent in lbs. per square inch at 45° Latitude, at Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude and Sea Level.
400	505.62	2.70382	504.2771	2.70267	247.6910—	2.39391
1	511.37	2.70874	510.0231	2.70759	250.5129	2.39883
2	517.17	2.71363	515.7747	2.71246	253.3378	2.40370
3	523.02	2.71852	521.6400	2.71737	256.2183	2.40861
4	528.93	2.72340	527.5332	2.72225	259.1130	2.41349
5	534.88	2.72826	533.4700	2.72711	262.0300—	2.41835
6	540.88	2.73310	539.4485	2.73195	264.9659	2.42319
7	546.94	2.73794	545.4940	2.73679	267.9353	2.42803
8	553.04	2.74276	551.5820	2.74161	270.9256	2.43285
9	559.20	2.74757	557.7248	2.74642	273.9429	2.43766
410	565.41	2.75236	563.9100	2.75121	276.9810	2.44245
1	571.67	2.75715	570.1700	2.75600	280.0529	2.44724
2	577.99	2.76192	576.4610	2.76077	283.1456	2.45201
3	584.36	2.76668	582.8163	2.76553	286.2662	2.45677
4	590.78	2.77143	589.2235	2.77028	289.4143	2.46152
5	597.25	2.77616	595.6760	2.77501	292.5837	2.46625
6	603.78	2.78088	602.1851	2.77973	295.7808	2.47097
7	610.36	2.78559	608.7517	2.78444	299.0060	2.47568
8	617.00	2.79029	615.3751	2.78914	302.2526	2.48038
9	623.69	2.79497	622.0425	2.79382	305.5344	2.48506
420	630.44	2.79964	628.7674	2.79849	308.8374	2.48973
1	637.24	2.80430	635.5505	2.80315	312.1692	2.49439
2	644.09	2.80895	642.3920	2.80780	315.5298	2.49904
3	651.01	2.81359	649.2920	2.81244	318.9188	2.50368
4	657.97	2.81821	656.2360	2.81706	322.3300	2.50830
5	665.00	2.82282	663.2390	2.82167	325.7693	2.51291
6	672.08	2.82742	670.3010	2.82627	329.2380	2.51751
7	679.22	2.83201	677.4230	2.83086	332.7362	2.52210
8	686.41	2.83658	684.5900	2.83543	336.2600	2.52667
429	693.66	2.84115	691.8310	2.84000	339.8130	2.53124
430	700.97	2.84570	699.1200	2.84455	343.3919	2.53579
1	708.34	2.85024	706.4640	2.84909	347.0005	2.54033
2	715.76	2.85478	713.8880	2.85363	350.6470	2.54487

HYPERBOLIC LOGARITHMS.

No.	Loge,	No.	Loge,	No.	Loge,	No.	Loge,
1.00	0.00000	1.54	0.43178	2.08	0.73237	2.61	0.95935
1.01	0.00995	.55	0.43826	.09	0.73716	.62	0.96317
.02	0.01980	.56	0.44469			.63	0.96698
.03	0.02956	.57	0.45108	2.10	0.74194	.64	0.97078
.04	0.03922	.58	0.45743	.11	0.74669	.65	0.97456
.05	0.04879	.59	0.46373	.12	0.75142	.66	0.97833
.06	0.05827			.13	0.75612	.67	0.98208
.07	0.06766	1.60	0.47000	.14	0.76081	.68	0.98582
.08	0.07696	.61	0.47623	.15	0.76547	.69	0.98954
.09	0.08618	.62	0.48243	.16	0.77011		
		.63	0.48858	.17	0.77473	2.70	0.99325
1.10	0.09531	.64	0.49470	.18	0.77933	.71	0.99695
.11	0.10436	.65	0.50078	.19	0.78390	.72	1.00063
.12	0.11333	.66	0.50682			.73	1.00430
.13	0.12222	.67	0.51282	2.20	0.78846	.74	1.00796
.14	0.13103	.68	0.51879	.21	0.79299	.75	1.01160
.15	0.13976	.69	0.52473	.22	0.79751	.76	1.01523
.16	0.14842			.23	0.80200	.77	1.01885
.17	0.15700	1.70	0.53063	.24	0.80648	.78	1.02445
.18	0.16551	.71	0.53649	.25	0.81093	.79	1.02604
.19	0.17395	.72	0.54232	.26	0.81536		
		.73	0.54812	.27	0.81978	2.80	1.02962
1.20	0.18232	.74	0.55389	.28	0.82418	.81	1.03318
.21	0.19062	.75	0.55962	.29	0.82855	.82	1.03674
.22	0.19885	.76	0.56531			.83	1.04028
.23	0.20701	.77	0.57098	2.30	0.83291	.84	1.04380
.24	0.21511	.78	0.57661	.31	0.83725	.85	1.04732
.25	0.22314	.79	0.58222	.32	0.84157	.86	1.05082
.26	0.23111			.33	0.84587	.87	1.05431
.27	0.23902	1.80	0.58779	.34	0.85015	.88	1.05779
.28	0.24686	.81	0.59333	.35	0.85442	.89	1.06126
.29	0.25464	.82	0.59884	.36	0.85866		
		.83	0.60432	.37	0.86289	2.90	1.06471
1.30	0.26236	.84	0.60977	.38	0.86710	.91	1.06815
.31	0.27003	.85	0.61519	.39	0.87129	.92	1.07158
.32	0.27763	.86	0.62058			.93	1.07500
.33	0.28518	.87	0.62594	2.40	0.87547	.94	1.07841
.34	0.29267	.88	0.63127	.41	0.87963	.95	1.08181
.35	0.30010	.89	0.63658	.42	0.88377	.96	1.08519
.36	0.30748			.43	0.88789	.97	1.08856
.37	0.31481	1.90	0.64185	.44	0.89200	.98	1.09192
.38	0.32208	.91	0.64710	.45	0.89609	.99	1.09527
.39	0.32930	.92	0.65233	.46	0.90016		
		.93	0.65752	.47	0.90422	3.00	1.09861
1.40	0.33647	.94	0.66269	.48	0.90826	.01	1.10194
.41	0.34359	.95	0.66783	.49	0.91228	.02	1.10526
.42	0.35066	.96	0.67294			.03	1.10856
.43	0.35767	.97	0.67803	2.50	0.91629	.04	1.11186
.44	0.36464	.98	0.68310	.51	0.92028	.05	1.11514
.45	0.37156	.99	0.68813	.52	0.92426	.06	1.11842
.46	0.37844			.53	0.92822	.07	1.12168
.47	0.38526	2.00	0.69315	.54	0.93216	.08	1.12493
.48	0.39204	.01	0.69813	.55	0.93609	.09	1.12817
.49	0.39878	.02	0.70310	.56	0.94001		
		.03	0.70804	.57	0.94391	3.10	1.13140
1.50	0.40547	.04	0.71295	.58	0.94779	.11	1.13462
.51	0.41211	.05	0.71784	.59	0.95166	.12	1.13783
.52	0.41871	.06	0.72271			.13	1.14103
.53	0.42527	.07	0.72755	2.60	0.95551	.14	1.14422

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log$_e$	No.	Log$_e$	No.	Log$_e$	No.	Log$_e$
3.15	1.14740	3.69	1.30563	4.22	1.43984	4.76	1.56025
.16	1.15057			.23	1.44220	.77	1.56235
.17	1.15373	3.70	1.30833	.24	1.44456	.78	1.56444
.18	1.15688	.71	1.31103	.25	1.44692	.79	1.56653
.19	1.16002	.72	1.31372	.26	1.44927		
		.73	1.31641	.27	1.45161	4.80	1.56862
3.20	1.16315	.74	1.31909	.28	1.45395	.81	1.57070
.21	1.16627	.75	1.32176	.29	1.45629	.82	1.57277
.22	1.16938	.76	1.32442			.83	1.57485
.23	1.17248	.77	1.32708	4.30	1.45862	.84	1.57691
.24	1.17557	.78	1.32972	.31	1.46094	.85	1.57898
.25	1.17866	.79	1.33237	.32	1.46326	.86	1.58104
.26	1.18173			.33	1.46557	.87	1.58309
.27	1.18479	3.80	1.33500	.34	1.46787	.88	1.58515
.28	1.18784	.81	1.33763	.35	1.47018	.89	1.58719
.29	1.19089	.82	1.34025	.36	1.47247		
		.83	1.34286	.37	1.47476	4.90	1.58924
3.30	1.19392	.84	1.34547	.38	1.47705	.91	1.59127
.31	1.19695	.85	1.34807	.39	1.47933	.92	1.59331
.32	1.19996	.86	1.35067			.93	1.59534
.33	1.20297	.87	1.35325	4.40	1.48160	.94	1.59737
.34	1.20597	.88	1.35584	.41	1.48387	.95	1.59939
.35	1.20896	.89	1.35841	.42	1.48614	.96	1.60141
.36	1.21194			.43	1.48840	.97	1.60342
.37	1.21491	3.90	1.36098	.44	1.49065	.98	1.60543
.38	1.21788	.91	1.36354	.45	1.49290	.99	1.60744
.39	1.22083	.92	1.36609	.46	1.49515		
		.93	1.36864	.47	1.49739	5.00	1.60944
3.40	1.22378	.94	1.37118	.48	1.49962	.01	1.61144
.41	1.22671	.95	1.37372	.49	1.50185	.02	1.61343
.42	1.22964	.96	1.37624			.03	1.61542
.43	1.23256	.97	1.37877	4.50	1.50408	.04	1.61741
.44	1.23547	.98	1.38128	.51	1.50630	.05	1.61939
.45	1.23837	.99	1.38379	.52	1.50851	.06	1.62137
.46	1.24127			.53	1.51072	.07	1.62334
.47	1.24415	4.00	1.38629	.54	1.51293	.08	1.62531
.48	1.24703	.01	1.38879	.55	1.51513	.09	1.62728
.49	1.24990	.02	1.39128	.56	1.51732		
		.03	1.39377	.57	1.51951	5.10	1.62924
3.50	1.25276	.04	1.39624	.58	1.52170	.11	1.63120
.51	1.25562	.05	1.39872	.59	1.52388	.12	1.63315
.52	1.25846	.06	1.40118			.13	1.63511
.53	1.26130	.07	1.40364	4.60	1.52606	.14	1.63705
.54	1.26413	.08	1.40610	.61	1.52823	.15	1.63900
.55	1.26695	.09	1.40855	.62	1.53039	.16	1.64094
.56	1.26976			.63	1.53256	.17	1.64287
.57	1.27257	4.10	1.41099	.64	1.53471	.18	1.64481
.58	1.27536	.11	1.41342	.65	1.53687	.19	1.64673
.59	1.27815	.12	1.41585	.66	1.53902		
		.13	1.41828	.67	1.54116	5.20	1.64866
3.60	1.28093	.14	1.42070	.68	1.54330	.21	1.65058
.61	1.28371	.15	1.42311	.69	1.54543	.22	1.65250
.62	1.28647	.16	1.42552			.23	1.65441
.63	1.28923	.17	1.42792	4.70	1.54756	.24	1.65632
.64	1.29198	.18	1.43031	.71	1.54969	.25	1.65823
.65	1.29473	.19	1.43270	.72	1.55181	.26	1.66013
.66	1.29746			.73	1.55393	.27	1.66203
.67	1.30019	4.20	1.43508	.74	1.55604	.28	1.66393
.68	1.30291	.21	1.43446	.75	1.55814	.29	1.66582

HYPERBOLIC LOGARITHMS —*Continued.*

No.	Log$_e$	No.	Log$_e$	No.	Log$_e$	No.	Log$_e$
5.30	1.66771	5.84	1.76473	6.38	1.85317	6.91	1.93297
.31	1.66959	.85	1.76644	.39	1.85473	.92	1.93442
.32	1.67147	.86	1.76815			.93	1.93586
.33	1.67335	.87	1.76985	6.40	1.85630	.94	1.93730
.34	1.67523	.88	1.77156	.41	1.85786	.95	1.93874
.35	1.67710	.89	1.77326	.42	1.85942	.96	1.94018
.36	1.67896			.43	1.86097	.97	1.94162
.37	1.68083	5.90	1.77495	.44	1.86253	.98	1.94305
.38	1.68269	.91	1.77665	.45	1.86408	.99	1.94448
.39	1.68455	.92	1.77834	.46	1.86563		
		.93	1.78002	.47	1.86718	7.00	1.94591
5.40	1.68640	.94	1.78174	.48	1.86872	.01	1.94734
.41	1.68825	.95	1.78339	.49	1.87026	.02	1.94876
.42	1.69010	.96	1.78507			.03	1.95019
.43	1.69194	.97	1.78675	6.50	1.87180	.04	1.95161
.44	1.69378	.98	1.78842	.51	1.87334	.05	1.95303
.45	1.69562	.99	1.79009	.52	1.87487	.06	1.95445
.46	1.69745			.53	1.87641	.07	1.95586
.47	1.69928	6.00	1.79176	.54	1.87794	.08	1.95727
.48	1.70111	.01	1.79342	.55	1.87947	.09	1.95869
.49	1.70293	.02	1.79509	.56	1.88099		
		.03	1.79675	.57	1.88251	7.10	1.96009
5.50	1.70475	.04	1.79840	.58	1.88403	.11	1.96150
.51	1.70656	.05	1.80006	.59	1.88555	.12	1.96291
.52	1.70838	.06	1.80171			.13	1.96431
.53	1.71019	.07	1.80336	6.60	1.88707	.14	1.96571
.54	1.71199	.08	1.80500	.61	1.88858	.15	1.96711
.55	1.71380	.09	1.80665	.62	1.89010	.16	1.96851
.56	1.71560			.63	1.89160	.17	1.96991
.57	1.71740	6.10	1.80829	.64	1.89311	.18	1.97130
.58	1.71919	.11	1.80993	.65	1.89462	.19	1.97269
.59	1.72098	.12	1.81156	.66	1.89612		
		.13	1.81319	.67	1.89762	7.20	1.97408
5.60	1.72277	.14	1.81482	.68	1.89912	.21	1.97547
.61	1.72455	.15	1.81645	.69	1.90061	.22	1.97686
.62	1.72633	.16	1.81808			.23	1.97824
.63	1.72811	.17	1.81970	6.70	1.90211	.24	1.97962
.64	1.72988	.18	1.82132	.71	1.90360	.25	1.98100
.65	1.73166	.19	1.82294	.72	1.90509	.26	1.98238
.66	1.73342			.73	1.90658	.27	1.98376
.67	1.73519	6.20	1.82455	.74	1.90806	.28	1.98513
.68	1.73695	.21	1.82616	.75	1.90954	.29	1.98650
.69	1.73871	.22	1.82777	.76	1.91102		
		.23	1.82938	.77	1.91250	7.30	1.98787
5.70	1.74047	.24	1.83098	.78	1.91398	.31	1.98924
.71	1.74222	.25	1.83258	.79	1.91545	.32	1.99061
.72	1.74397	.26	1.83418			.33	1.99198
.73	1.74572	.27	1.83578	6.80	1.91692	.34	1.99334
.74	1.74746	.28	1.83737	.81	1.91839	.35	1.99470
.75	1.74920	.29	1.83896	.82	1.91986	.36	1.99606
.76	1.75094			.83	1.92132	.37	1.99742
.77	1.75267	6.30	1.84055	.84	1.92279	.38	1.99877
.78	1.75440	.31	1.84214	.85	1.92425	.39	2.00013
.79	1.75613	.32	1.84372	.86	1.92571		
		.33	1.84530	.87	1.92716	7.40	2.00148
5.80	1.75786	.34	1.84688	.88	1.92862	.41	2.00283
.81	1.75958	.35	1.84845	.89	1.93007	.42	2.00418
.82	1.76130	.36	1.85003			.43	2.00553
.83	1.76302	.37	1.85160	6.90	1.93152	.44	2.00687

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Loge,	No.	Loge,	No.	Loge,	No.	Loge,
7.45	2.00821	7.99	2.07819	8.52	2.14242	9.06	2.20387
.46	2.00956			.53	2.14359	.07	2.20497
.47	2.01090	8.00	2.07944	.54	2.14476	.08	2.20607
.48	2.01223	.01	2.08069	.55	2.14593	.09	2.20718
.49	2.01357	.02	2.08194	.56	2.14710		
		.03	2.08318	.57	2.14827	9.10	2.20827
7.50	2.01490	.04	2.08443	.58	2.14943	.11	2.20937
.51	2.01624	.05	2.08567	.59	2.15060	.12	2.21047
.52	2.01757	.06	2.08691			.13	2.21157
.53	2.01890	.07	2.08815	8.60	2.15176	.14	2.21266
.54	2.02022	.08	2.08939	.61	2.15292	.15	2.21375
.55	2.02155	.09	2.09063	.62	2.15409	.16	2.21585
.56	2.02287			.63	2.15524	.17	2.21694
.57	2.02419	8.10	2.09186	.64	2.15640	.18	2.21703
.58	2.02551	.11	2.09310	.65	2.15756	.19	2.21812
.59	2.02683	.12	2.09433	.66	2.15871		
		.13	2.09556	.67	2.15987	9.20	2.21920
7.60	2.02815	.14	2.09679	.68	2.16102	.21	2.22029
.61	2.02946	.15	2.09802	.69	2.16217	.22	2.22138
.62	2.03078	.16	2.09924			.23	2.22246
.63	2.03209	.17	2.10047	8.70	2.16332	.24	2.22354
.64	2.03340	.18	2.10169	.71	2.16447	.25	2.22462
.65	2.03471	.19	2.10291	.72	2.16562	.26	2.22570
.66	2.03601			.73	2.16677	.27	2.22678
.67	2.03732	8.20	2.10413	.74	2.16791	.28	2.22786
.68	2.03862	.21	2.10535	.75	2.16905	.29	2.22894
.69	2.03992	.22	2.10657	.76	2.17020		
		.23	2.10779	.77	2.17134	9.30	2.23001
7.70	2.04122	.24	2.10900	.78	2.17248	.31	2.23109
.71	2.04252	.25	2.11021	.79	2.17361	.32	2.23216
.72	2.04381	.26	2.11142			.33	2.23324
.73	2.04511	.27	2.11263	8.80	2.17475	.34	2.23431
.74	2.04640	.28	2.11384	.81	2.17589	.35	2.23538
.75	2.04769	.29	2.11505	.82	2.17702	.36	2.23645
.76	2.04898			.83	2.17816	.37	2.23751
.77	2.05027	8.30	2.11626	.84	2.17929	.38	2.23858
.78	2.05156	.31	2.11746	.85	2.18042	.39	2.23965
.79	2.05284	.32	2.11866	.86	2.18155		
		.33	2.11986	.87	2.18267	9.40	2.24071
7.80	2.05412	.34	2.12106	.88	2.18380	.41	2.24177
.81	2.05541	.35	2.12226	.89	2.18493	.42	2.24284
.82	2.05668	.36	2.12346			.43	2.24390
.83	2.05796	.37	2.12465	8.90	2.18605	.44	2.24596
.84	2.05924	.38	2.12585	.91	2.18717	.45	2.24601
.85	2.06051	.39	2.12704	.92	2.18830	.46	2.24707
.86	2.06179			.93	2.18942	.47	2.24813
.87	2.06306	8.40	2.12823	.94	2.19054	.48	2.24918
.88	2.06433	.41	2.12942	.95	2.19165	.49	2.25024
.89	2.06560	.42	2.13061	.96	2.19277		
		.43	2.13180	.97	2.19389	9.50	2.25129
7.90	2.06686	.44	2.13298	.98	2.19500	.51	2.25234
.91	2.06813	.45	2.13417	.99	2.19611	.52	2.25340
.92	2.06939	.46	2.13535			.53	2.25444
.93	2.07065	.47	2.13653	9.00	2.19722	.54	2.25549
.94	2.07191	.48	2.13771	.01	2.19834	.55	2.25654
.95	2.07317	.49	2.13889	.02	2.19944	.56	2.25759
.96	2.07443			.03	2.20055	.57	2.25863
.97	2.07568	8.50	2.14007	.04	2.21066	.58	2.25968
.98	2.07694	.51	2.14124	.05	2.20276	.59	2.26072

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log$_e$,	No.	Log$_e$,	No.	Log$_e$,	No.	Log$_e$,
9.60	2.26176	10.14	2.31649	10.68	2.36837	11.21	2.41681
.61	2.26280	.15	2.31747	.69	2.36931	.22	2.41770
.62	2.26384	.16	2.31846			.23	2.41859
.63	2.26488	.17	2.31944	10.70	2.37024	.24	2.41948
.64	2.26592	.18	2.32043	.71	2.37118	.25	2.42037
.65	2.26696	.19	2.32141	.72	2.37211	.26	2.42126
.66	2.26799			.73	2.37304	.27	2.42214
.67	2.26903	10.20	2.32239	.74	2.37398	.28	2.42303
.68	2.27006	.21	2.32337	.75	2.37491	.29	2.42392
.69	2.27109	.22	2.32435	.76	2.37584		
		.23	2.32532	.77	2.37676	11.30	2.42480
9.70	2.27213	.24	2.32630	.78	2.37769	.31	2.42569
.71	2.27316	.25	2.32728	.79	2.37862	.32	2.42657
.72	2.27419	.26	2.32825			.33	2.42745
.73	2.27521	.27	2.32923	10.80	2.37955	.34	2.42834
.74	2.27624	.28	2.33020	.81	2.38047	.35	2.42922
.75	2.27727	.29	2.33117	.82	2.38140	.36	2.43010
.76	2.27829			.83	2.38232	.37	2.43098
.77	2.27932	10.30	2.33214	.84	2.38324	.38	2.43186
.78	2.28034	.31	2.33311	.85	2.38417	.39	2.43274
.79	2.28136	.32	2.33408	.86	2.38509		
		.33	2.33505	.87	2.38601	11.40	2.43361
9.80	2.28238	.34	2.33602	.88	2.38693	.41	2.43449
.81	2.28340	.35	2.33699	.89	2.38785	.42	2.43537
.82	2.28442	.36	2.33795			.43	2.43624
.83	2.28544	.37	2.33892	10.90	2.38876	.44	2.43712
.84	2.28646	.38	2.33988	.91	2.38968	.45	2.43799
.85	2.28747	.39	2.34084	.92	2.39060	.46	2.43886
.86	2.28849			.93	2.39151	.47	2.43974
.87	2.28950	10.40	2.34181	.94	2.39243	.48	2.44061
.88	2.29051	.41	2.34277	.95	2.39334	.49	2.44148
.89	2.29152	.42	2.34373	.96	2.39425		
		.43	2.34468	.97	2.39516	11.50	2.44235
9.90	2.29253	.44	2.34564	.98	2.39608	.51	2.44322
.91	2.29354	.45	2.34660	.99	2.39699	.52	2.44408
.92	2.29455	.46	2.34756			.53	2.44495
.93	2.29556	.47	2.34851	11.00	2.39790	.54	2.44582
.94	2.29657	.48	2.34947	.01	2.39880	.55	2.44669
.95	2.29757	.49	2.35042	.02	2.39971	.56	2.44755
.96	2.29858			.03	2.40062	.57	2.44842
.97	2.29958	10.50	2.35138	.04	2.40153	.58	2.44928
.98	2.30058	.51	2.35233	.05	2.40243	.59	2.45014
.99	2.30158	.52	2.35328	.06	2.40334		
		.53	2.35423	.07	2.40424	11.60	2.45101
10.00	2.30259	.54	2.35518	.08	2.40514	.61	2.45187
.01	2.30358	.55	2.35613	.09	2.40604	.62	2.45273
.02	2.30458	.56	2.35707			.63	2.45359
.03	2.30558	.57	2.35802	11.10	2.40695	.64	2.45445
.04	2.30658	.58	2.35897	.11	2.40785	.65	2.45531
.05	2.30757	.59	2.35991	.12	2.40875	.66	2.45616
.06	2.30857			.13	2.40964	.67	2.45702
.07	2.30956	10.60	2.36085	.14	2.41054	.68	2.45788
.08	2.31055	.61	2.36180	.15	2.41144	.69	2.45873
.09	2.31155	.62	2.36274	.16	2.41234		
		.63	2.36368	.17	2.41323	11.70	2.45959
10.10	2.31254	.64	2.36462	.18	2.41413	.71	2.46044
.11	2.31353	.65	2.36556	.19	2.41502	.72	2.46130
.12	2.31451	.66	2.36650			.73	2.46215
.13	2.31550	.67	2.36744	11.20	2.41591	.74	2.46300

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Loge,	No.	Loge,	No.	Loge,	No.	Loge,
11.75	2.46385	12.29	2.50879	12.82	2.55101	13.36	2.59227
.76	2.46470			.83	2.55179	.37	2.59301
.77	2.46555	12.30	2.50960	.84	2.55257	.38	2.59376
.78	2.46640	.31	2.51041	.85	2.55334	.39	2.59451
.79	2.46725	.32	2.51122	.86	2.55412		
		.33	2.51204	.87	2.55490	13.40	2.59525
11.80	2.46810	.34	2.51285	.88	2.55568	.41	2.59600
.81	2.46895	.35	2.51366	.89	2.55645	.42	2.59675
.82	2.46979	.36	2.51447			.43	2.59749
.83	2.47064	.37	2.51527	12.90	2.55723	.44	2.59824
.84	2.47148	.38	2.51608	.91	2.55800	.45	2.59898
.85	2.47233	.39	2.51689	.92	2.55878	.46	2.59972
.86	2.47317			.93	2.55955	.47	2.60047
.87	2.47401	12.40	2.51770	.94	2.56032	.48	2.60121
.88	2.47486	.41	2.51850	.95	2.56110	.49	2.60195
.89	2.47570	.42	2.51931	.96	2.56187		
		.43	2.52011	.97	2.56264	13.50	2.60269
11.90	2.47654	.44	2.52092	.98	2.56341	.51	2.60343
.91	2.47738	.45	2.52172	.99	2.56418	.52	2.60417
.92	2.47822	.46	2.52252			.53	2.60491
.93	2.47906	.47	2.52333	13.00	2.56495	.54	2.60565
.94	2.47989	.48	2.52413	.01	2.56572	.55	2.60639
.95	2.48073	.49	2.52593	.02	2.56649	.56	2.60712
.96	2.48157			.03	2.56725	.57	2.60786
.97	2.48240	12.50	2.52573	.04	2.56802	.58	2.60860
.98	2.48324	.51	2.52653	.05	2.56879	.59	2.60933
.99	2.48407	.52	2.52733	.06	2.56955		
		.53	2.52813	.07	2.57032	13.60	2.61007
12.00	2.48491	.54	2.52892	.08	2.57108	.61	2.61081
.01	2.48574	.55	2.52972	.09	2.57185	.62	2.61154
.02	2.48657	.56	2.53052			.63	2.61227
.03	2.48740	.57	2.53131	13.10	2.57261	.64	2.61301
.04	2.48823	.58	2.53211	.11	2.57338	.65	2.61374
.05	2.48906	.59	2.53290	.12	2.57414	.66	2.61447
.06	2.48989			.13	2.57490	.67	2.61520
.07	2.49072	12.60	2.53370	.14	2.57566	.68	2.61594
.08	2.49155	.61	2.53449	.15	2.57642	.69	2.61667
.09	2.49238	.62	2.53528	.16	2.57718		
		.63	2.53608	.17	2.57794	13.70	2.61740
12.10	2.49321	.64	2.53687	.18	2.57870	.71	2.61813
.11	2.49403	.65	2.53756	.19	2.57946	.72	2.61885
.12	2.49486	.66	2.53845			.73	2.61958
.13	2.49568	.67	2.53924	13.20	2.58022	.74	2.62031
.14	2.49651	.68	2.54003	.21	2.58097	.75	2.62104
.15	2.49733	.69	2.54081	.22	2.58173	.76	2.62177
.16	2.49815			.23	2.58249	.77	2.62249
.17	2.49897	12.70	2.54160	.24	2.58324	.78	2.62322
.18	2.49980	.71	2.54239	.25	2.58400	.79	2.62394
.19	2.50062	.72	2.54318	.26	2.58475		
		.73	2.54396	.27	2.58551	13.80	2.62467
12.20	2.50144	.74	2.54475	.28	2.58626	.81	2.62539
.21	2.50226	.75	2.54553	.29	2.58701	.82	2.62612
.22	2.50307	.76	2.54632			.83	2.62684
.23	2.50389	.77	2.54710	13.30	2.58776	.84	2.62756
.24	2.50471	.78	2.54788	.31	2.58852	.85	2.62829
.25	2.50553	.79	2.54866	.32	2.58927	.86	2.62901
.26	2.50634			.33	2.59002	.87	2.62973
.27	2.50716	12.80	2.54945	.34	2.59077	.88	2.63045
.28	2.50797	.81	2.55023	.35	2.59152	.89	2.63117

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log$_e$,	No.	Log$_e$,	No.	Log$_e$,	No.	Log$_e$,
13.90	2.63189	14.44	2.67000	14.98	2.70672	15.51	2.74149
.91	2.63261	.45	2.67069	.99	2.70738	.52	2.74213
.92	2.63333	.46	2.67139			.53	2.74277
.93	2.63404	.47	2.67208	15.00	2.70805	.54	2.74342
.94	2.63476	.48	2.67277	.01	2.70872	.55	2.74406
.95	2.63548	.49	2.67346	.02	2.70938	.56	2.74470
.96	2.63620			.03	2.71005	.57	2.74535
.97	2.63691	14.50	2.67415	.04	2.71071	.58	2.74599
.98	2.63763	.51	2.67484	.05	2.71138	.59	2.74663
.99	2.63834	.52	2.67553	.06	2.71204		
		.53	2.67622	.07	2.71271	15.60	2.74727
14.00	2.63906	.54	2.67690	.08	2.71337	.61	2.74791
.01	2.63977	.55	2.67759	.09	2.71403	.62	2.74855
.02	2.64049	.56	2.67828			.63	2.74919
.03	2.64120	.57	2.67896	15.10	2.71469	.64	2.79983
.04	2.64191	.58	2.67965	.11	2.71536	.65	2.75047
.05	2.64262	.59	2.68034	.12	2.71602	.66	2.75111
.06	2.64333			.13	2.71668	.67	2.75175
.07	2.64405	14.60	2.68102	.14	2.71734	.68	2.75239
.08	2.64476	.61	2.68171	.15	2.71800	.69	2.75302
.09	2.64547	.62	2.68239	.16	2.71866		
		.63	2.68307	.17	2.71932	15.70	2.75366
14.10	2.64617	.64	2.68376	.18	2.71998	.71	2.75430
.11	2.64688	.65	2.68444	.19	2.72064	.72	2.75493
.12	2.64659	.66	2.68512			.73	2.75557
.13	2.64830	.67	2.68580	15.20	2.72130	.74	2.75621
.14	2.64901	.68	2.68649	.21	2.72195	.75	2.75684
.15	2.64971	.69	2.68717	.22	2.72261	.76	2.75748
.16	2.65042			.23	2.72327	.77	2.75811
.17	2.65113	14.70	2.68785	.24	2.72392	.78	2.75874
.18	2.65183	.71	2.68853	.25	2.72458	.79	2.75938
.19	2.65254	.72	2.68921	.26	2.72524		
		.73	2.68989	.27	2 72589	15.80	2.76001
14.20	2.65324	.74	2.69057	.28	2.72654	.81	2.76064
.21	2.65395	.75	2.69124	.29	2.72720	.82	2.76128
.22	2.65465	.76	2.69192			.83	2.76191
.23	2.65535	.77	2.69260	15.30	2.72785	.84	2.76254
.24	2.65606	.78	2.69328	.31	2.72851	.85	2.76317
.25	2.65676	.79	2.69395	.32	2.72916	.86	2.76380
.26	2.65746			.33	2.72981	.87	2.76443
.27	2.65816	14.80	2.69463	.34	2.73046	.88	2.76506
.28	2.65886	.81	2.69530	.35	2.73112	.89	2.76569
.29	2.65956	.82	2.69598	.36	2.73177		
		.83	2.69665	.37	2.73242	15.90	2.76632
14.30	2.66026	.84	2.69733	.38	2.73307	.91	2.76695
.31	2.66096	.85	2.69800	.39	2.73372	.92	2.76758
.32	2.66166	.86	2.69867			.93	2.76820
.33	2.66236	.87	2.69935	15.40	2.73437	.94	2.76883
.34	2.66305	.88	2.70002	.41	2.73502	.95	2.76946
.35	2.66375	.89	2.70069	.42	2.73567	.96	2.77009
.36	2.66445			.43	2.73631	.97	2.77071
.37	2.66514	14.90	2.70136	.44	2.73696	.98	2.77134
.38	2.66584	.91	2.70203	.45	2.73761	.99	2.77196
.39	2.66653	.92	2.70270	.46	2.73826		
		.93	2.70337	.47	2.73890	16.00	2.77259
14.40	2.66723	.94	2.70404	.48	2.73955	.01	2.77321
.41	2.66792	.95	2.70471	.49	2.74019	.02	2.77384
.42	2.66862	.96	2.70538			.03	2.77446
.43	2.66931	.97	2.70605	15.50	2.75084	.04	2.77509

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Loge,	No.	Loge,	No.	Loge,	No.	Loge,
16.05	2.77571	16.59	2.80880	17.12	2.84025	17.66	2.87130
.06	2.77633			.13	2.84083	.67	2 87187
.07	2.77695	16.60	2.80940	.14	2.84142	.68	2.87243
.08	2.77758	.61	2.81001	.15	2.84200	.69	2.87300
.09	2.77820	.62	2.81061	.16	2.84258		
		.63	2.81121	.17	2.84316	17.70	2.87356
16.10	2.77882	.64	2.81181	.18	2.84375	.71	2.87413
.11	2.77944	.65	2.81241	.19	2.84433	.72	2.87469
.12	2.78006	.66	2.81301			.73	2.87526
.13	2.78068	.67	2.81361	17.20	2.84491	.74	2.87582
.14	2.78130	.68	2.81421	.21	2.84549	.75	2.87639
.15	2.78192	.69	2.81481	.22	2.84607	.76	2.87695
.16	2.78254			.23	2.84665	.77	2.87751
.17	2.78316	16.70	2.81541	.24	2.84723	.78	2.87807
.18	2.78378	.71	2.81601	.25	2.84781	.79	2.87864
.19	2.78439	.72	2.81661	.26	2.84839		
		.73	2.81720	.27	2.84897	17.80	2.87920
16.20	2.78501	.74	2.81780	.28	2.84955	.81	2.87976
.21	2.78563	.75	2.81840	.29	2.85013	.82	2.88032
.22	2.78625	.76	2.81900			.83	2.88088
.23	2.78686	.77	2.81959	17.30	2.85071	.84	2.88144
.24	2.78748	.78	2.82019	.31	2.85128	.85	2.88200
.25	2.78809	.79	2.82078	.32	2.85186	.86	2.88256
.26	2.78871			.33	2.85244	.87	2.88312
.27	2.78932	16.80	2.82138	.34	2.85302	.88	2.88368
.28	2.78994	.81	2.82197	.35	2.85359	.89	2.88424
.29	2.79055	.82	2.82257	.36	2.85417		
		.83	2.82316	.37	2.85474	17.90	2.88480
16.30	2.79117	.84	2.82376	.38	2.85532	.91	2.88536
.31	2.79178	.85	2.82435	.39	2.85590	.92	2.88592
.32	2.79239	.86	2.82484			.93	2.88648
.33	2.79300	.87	2.82554	17.40	2.85647	.94	2.88703
.34	2.79362	.88	2.82513	.41	2.85704	.95	2.88759
.35	2.79423	.89	2.82672	.42	2.85762	.96	2.88815
.36	2.79484			.43	2.85819	.97	2.88870
.37	2.79545	16.90	2.82731	.44	2.85877	.98	2.88926
.38	2.79606	.91	2.82791	.45	2.85934	.99	2.88982
.39	2.79667	.92	2.82850	.46	2.85991		
		.93	2.82909	.47	2.86049	18.00	2.89037
16.40	2.79728	.94	2.82968	.48	2.86106	.01	2.89093
.41	2.79789	.95	2.83027	.49	2.86163	.02	2.89148
.42	2.79850	.96	2.83086			.03	2.89204
.43	2.79911	.97	2.83145	17.50	2.86220	.04	2.89259
.44	2.79972	.98	2.83204	.51	2.86277	.05	2.89315
.45	2.80033	.99	2.83263	.52	2.86334	.06	2.89370
.46	2.80093			.53	2.86391	.07	2.89425
.47	2.80154	17.00	2.83321	.54	2.86448	.08	2.89481
.48	2.80215	.01	2.83380	.55	2.86505	.09	2.89536
.49	2.80275	.02	2.83439	.56	2.86562		
		.03	2.83498	.57	2.86619	18.10	2.89591
16.50	2.80336	.04	2.83556	.58	2.86676	.11	2.89646
.51	2.80397	.05	2.83615	.59	2.86733	.12	2.89702
.52	2.80457	.06	2.83674			.13	2.89757
.53	2.80518	.07	2.83732	17.60	2.86790	.14	2.89812
.54	2.80578	.08	2.83791	.61	2.86847	.15	2.89867
.55	2.80639	.09	2.83849	.62	2.86903	.16	2.89922
.56	2.80699			.63	2.86960	.17	2.89977
.57	2.80759	17.10	2.83908	.64	2.87017	.18	2.90032
.58	2.80820	.11	2.83966	.65	2.87074	.19	2.90087

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Loge,	No.	Loge,	No.	Loge,	No.	Loge,
18.20	2.90142	18.74	2.93066	19.28	2.95907	19.81	2.98619
.21	2.90197	.75	2.93119	.29	2.95959	.82	2.98669
.22	2.90242	.76	2.93173			.83	2.98720
.23	2.90307	.77	2.93226	19.30	2.96011	.84	2.98770
.24	2.90362	.78	2.93279	.31	2.96062	.85	2.98820
.25	2.90417	.79	2.93333	.32	2.96114	.86	2.98871
.26	2.90471			.33	2.96166	.87	2.98921
.27	2.90526	18.80	2.93386	.34	2.96218	.88	2.98971
.28	2.90581	.81	2.93439	.35	2.96269	.89	2.99022
.29	2.90635	.82	2.93482	.36	2.96321		
		.83	2.93545	.37	2.96373	19.90	2.99072
18.30	2.90690	.84	2.93598	.38	2.96424	.91	2.99122
.31	2.90745	.85	2.93651	.39	2.96476	.92	2.99172
.32	2.90799	.86	2.93704			93	2.99223
.33	2.90854	.87	2.93757	19.40	2.96527	.94	2.99273
.34	2.90908	.88	2.93810	.41	2.96579	.95	2.99323
.35	2.90963	.89	2.93863	.42	2.96630	.96	2.99373
.36	2.91017			.43	2.96682	.97	2.99423
.37	2.91072	18.90	2.93916	.44	2.96733	.98	2.99473
.38	2.91126	.91	2.93969	.45	2.96785	.99	2.99523
.39	2.91181	.92	2.94022	.46	2.96836		
		.93	2.94075	.47	2.96888	20.00	2.99573
18.40	2.91235	.94	2.94128	.48	2.96939	.01	2.99623
.41	2.91289	.95	2.94180	.49	2.96990	.02	2.99673
.42	2.91344	.96	2.94233			.03	2.99723
.43	2.91398	.97	2.94286	19.50	2.97041	.04	2.99773
.44	2.91452	.98	2.94339	.51	2.97093	.05	2.99823
.45	2.91506	.99	2.94391	.52	2.97144	.06	2.99873
.46	2.91561			.53	2.97195	.07	2.99923
.47	2.91615	19.00	2.94444	.54	2.97246	.08	2.99972
.48	2.91669	.01	2.94497	.55	2.97298	.09	3.00022
.49	2.91723	.02	2.94549	.56	2.97349		
		.03	2.94602	.57	2.97400	20.10	3.00072
18.50	2.91777	.04	2.94654	.58	2.97451	.11	3.00122
.51	2.91831	.05	2.94707	.59	2.97502	.12	3.00171
.52	2.91885	.06	2.94759			.13	3.00221
.53	2.91939	.07	2.94812	19.60	2.97553	.14	3.00271
.54	2.91993	.08	2.94864	.61	2.97604	.15	3.00320
.55	2.92047	.09	2.94916	.62	2.97655	.16	3.00370
.56	2.92101			.63	2.97706	.17	3.00420
.57	2.92155	19.10	2.94969	.64	2.97757	.18	3.00469
.58	2.92209	.11	2.95021	.65	2.97808	.19	3.00519
.59	2.92262	.12	2.95074	.66	2.97859		
		.13	2.95126	.67	2.97909	20.20	3.00568
18.60	2.92316	.14	2.95178	.68	2.97960	.21	3.00618
.61	2.92370	.15	2.95230	.69	2.98011	.22	3.00667
.62	2.92424	.16	2.95282			.23	3.00717
.63	2.92477	.17	2.95335	19.70	2.98062	.24	3.00766
.64	2.92531	.18	2.95387	.71	2.98113	.25	3.00815
.65	2.92585	.19	2.95439	.72	2.98163	.26	3.00865
.66	2.92638			.73	2.98214	.27	3.00914
.67	2.92692	19.20	2.95491	.74	2.98265	.28	3.00964
.68	2.92745	.21	2.95543	.75	2.98315	.29	3.01013
.69	2.92799	.22	2.95695	.76	2.98366		
		.23	2.95647	.77	2.98417	20.30	3.01062
18.70	2.92852	.24	2.95699	.78	2.98467	.31	3.01111
.71	2.92906	.25	2.95751	.79	2.98518	.32	3.01161
.72	2.92959	.26	2.95803			.33	3.01210
.73	2.93013	.27	2.95855	19.80	2.98568	.34	3.01259

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Loge,	No.	Loge,	No.	Loge,	No.	Loge,
20.35	3.01308	20.89	3.03927	21.42	3.06433	21.96	3.08922
.36	3.01357			.43	3.06479	.97	3.08968
.37	3.01406	20.90	3.03975	.44	3.06526	.98	3.09013
.38	3.01455	.91	3.04023	.45	3.06572	.99	3.09059
.39	3.01504	.92	3.04071	.46	3.06619		
		.93	3.04118	.47	3.06666	22.00	3.09104
20.40	3.01554	.94	3.04166	.48	3.06712	.01	3.09150
.41	3.01603	.95	3.04214	.49	3.06759	.02	3.09195
.42	3.01651	.96	3.04262			.03	3.09241
.43	3.01700	.97	3.04309	21.50	3.06805	.04	3.09286
.44	3.01749	.98	3.04357	.51	3.06852	.05	3.09331
.45	3.01798	.99	3.04405	.52	3.06898	.06	3.09377
.46	3.01847			.53	3.06945	.07	3.09422
.47	3.01896	21.00	3.04452	.54	3.06991	.08	3.09467
.48	3.01945	.01	3.04500	.55	3.07038	.09	3.09513
.49	3.01984	.02	3.04547	.56	3.07084		
		.03	3 04595	.57	3.07130	22.10	3.09558
20.50	3.02043	.04	3.04643	.58	3.07177	.11	3.09603
.51	3.02091	.05	3.04690	.59	3.07223	.12	3.09648
.52	3.02140	.06	3.04738			.13	3.09693
.53	3.02189	.07	3.04785	21.60	3.07269	.14	3.09739
.54	3.02237	.08	3.04832	.61	3.07316	.15	3.09784
.55	3.02286	.09	3.04880	.62	3.07362	.16	3.09829
.56	3.02335			.63	3.07408	.17	3.09874
.57	3.02383	21.10	3.04927	.64	3.07454	.18	3.09919
.58	3.02432	.11	3.04975	.65	3.07501	.19	3.09964
.59	3.02481	.12	3.05022	.66	3.07547		
		.13	3.05069	.67	3.07593	22.20	3.10009
20.60	3.02529	.14	3.05117	.68	3.07639	.21	3.10054
.61	3.02578	.15	3.05164	.69	3.07685	.22	3.10099
.62	3.02626	.16	3.05211			.23	3.10144
.63	3.02675	.17	3.05259	21.70	3.07731	.24	3.10189
.64	3.02723	.18	3.05306	.71	3.07777	.25	3.10234
.65	3.02772	.19	3.05353	.72	3.07823	.26	3.10279
.66	3.02820			.73	3.07869	.27	3.10324
.67	3.02868	21.20	3.05400	.74	3.07915	.28	3.10369
.68	3.02917	.21	3.05447	.75	3.07961	.29	3.10414
.69	3.02965	.22	3.05494	.76	3.08007		
		.23	3.05542	.77	3.08053	22.30	3.10459
20.70	3.03013	.24	3.05589	.78	3.08099	.31	3.10504
.71	3.03062	.25	3.05636	.79	3.08145	.32	3.10548
.72	3.03110	.26	3.05683			.33	3.10593
.73	3.03158	.27	3.05730	21.80	3.08191	.34	3.10638
.74	3.03206	.28	3.05777	.81	3.08237	.35	3.10683
.75	3.03255	.29	3.05824	.82	3.08283	.36	3.10727
.76	3.03303			.83	3.08329	.37	3.10772
.77	3.03351	21.30	3.05871	.84	3.08374	.38	3.10817
.78	3.03399	.31	3.05918	.85	3.08420	.39	3.10861
.79	3.03447	.32	3.05964	.86	3.08466		
		.33	3.06011	.87	3.08512	22.40	3.10906
20.80	3.03595	.34	3.06058	.88	3.08557	.41	3.10951
.81	3.03543	.35	3.06105	.89	3.08603	.42	3.10995
.82	3.03591	.36	3.06152			.43	3.11040
.83	3.03639	.37	3.06199	21.90	3.08649	.44	3.11085
.84	3.03687	.38	3.06246	.91	3.08694	.45	3.11129
.85	3.03735	.39	3.06292	.92	3.08740	.46	3.11174
.86	3.03783			.93	3.08786	.47	3.11218
.87	3.03831	21.40	3.06339	.94	3.08831	.48	3.11263
.88	3.03879	.41	3.06386	.95	3.08877	.49	3.11307

HYPERBOLIC LOGARITHMS —*Continued.*

No.	Log$_e$	No.	Log$_e$	No.	Log$_e$	No.	Log$_e$
22.50	3.11352	23.04	3.13723	23.58	3.16040	24.11	3.18263
.51	3.11396	.05	3.13767	.59	3.16082	.12	3.18304
.52	3.11440	.06	3.13810			.13	3.18346
.53	3.11485	.07	3.13853	23.60	3.16125	.14	3.18387
.54	3.11529	.08	3.13897	.61	3.16167	.15	3.18428
.55	3.11574	.09	3.13940	.62	3.16209	.16	3.18470
.56	3.11618			.63	3.16252	.17	3.18511
.57	3.11662	23.10	3.13983	.64	3.16294	.18	3.18553
.58	3.11706	.11	3.14027	.65	3.16336	.19	3.18594
.59	3.11751	.12	3.14070	.66	3.16379		
		.13	3.14113	.67	3.16421	24.20	3.18635
22.60	3.11795	.14	3.14156	.68	3.16463	.21	3.18677
.61	3.11839	.15	3.14199	.69	3.16505	.22	3.18718
.62	3.11883	.16	3.14243			.23	3.18759
.63	3.11928	.17	3.14286	23.70	3.16548	.24	3.18800
.64	3.11972	.18	3.14329	.71	3.16590	.25	3.18842
.65	3.12016	.19	3.14372	.72	3.16632	.26	3.18883
.66	3.12060			.73	3.16674	.27	3.18924
.67	3.12104	23.20	3.14415	.74	3.16716	.28	3.18965
.68	3.12148	.21	3.14458	.75	3.16758	.29	3.19006
.69	3.12192	.22	3.14501	.76	3.16800		
		.23	3.14544	.77	3.16842	24.30	3.19048
22.70	3.12237	.24	3.14588	.78	3.16885	.31	3.19089
.71	3.12281	.25	3.14631	.79	3.16927	.32	3.19130
.72	3.12325	.26	3.14674			.33	3.19171
.73	3.12369	.27	3.14617	23.80	3.16969	.34	3.19212
.74	3.12413	.28	3.14759	.81	3.17011	.35	3.19253
.75	3.12467	.29	3.14802	.82	3.17053	.36	3.19294
.76	3.12500			.83	3.17095	.37	3.19335
.77	3.12544	23.30	3.14845	.84	3.17137	.38	3.19376
.78	3.12588	.31	3.14888	.85	3.17178	.39	3.19417
.79	3.12632	.32	3.14931	.86	3.17220		
		.33	3.14974	.87	3.17262	24.40	3.19458
22.80	3.12676	.34	3.15017	.88	3.17304	.41	3.19499
.81	3.12720	.35	3.15060	.89	3.17346	.42	3.19540
.82	3.12764	.36	3.15103			.43	3.19581
.83	3.12808	.37	3.15145	23.90	3.17388	.44	3.19622
.84	3.12851	.38	3.15188	.91	3.17430	.45	3.19663
.85	3.12895	.39	3.15231	.92	3.17472	.46	3.19704
.86	3.12939			.93	3.17513	.47	3.19745
.87	3.12983	23.40	3.15274	.94	3.17555	.48	3.19786
.88	3.13026	.41	3.15316	.95	3.17597	.49	3.19827
.89	3.13070	.42	3.15359	.96	3.17639		
		.43	3.15402	.97	3.17680	24.50	3.19867
22.90	3.13114	.44	3.15444	.98	3.17722	.51	3.19908
.91	3.13157	.45	3.15487	.99	3.17764	.52	3.19949
.92	3.13201	.46	3.15530			.53	3.19990
.93	3.13245	.47	3.15572	24.00	3.17805	.54	3.20030
.94	3.13288	.48	3.15615	.01	3.17847	.55	3.20071
.95	3.13332	.49	3.15657	.02	3.17889	.56	3.20112
.96	3.13375			.03	3.17930	.57	3.20153
.97	3.13419	23.50	3.15700	.04	3.17972	.58	3.20193
.98	3.13462	.51	3.15743	.05	3.18014	.59	3.20234
.99	3.13506	.52	3.15785	.06	3.18055		
		.53	3.15828	.07	3.18097	24.60	3.20275
23.00	3.13549	.54	3.15870	.08	3.18138	.61	3.20315
.01	3.13593	.55	3.15923	.09	3.18180	.62	3.20356
.02	3.13636	.56	3.15955			.63	3.20397
.03	3.13680	.57	3.15997	24.10	3.18221	.64	3.20437

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log$_e$,	No.	Log$_e$,	No.	Log$_e$,	No.	Log$_e$,
24.65	3.20478	25.19	3.22645	25.72	3.24727	26.26	3.26805
.66	3.20518			.73	3.24766	.27	3.26843
.67	3.20559	25.20	3.22684	.74	3.24805	.28	3.26881
.68	3.20599	.21	3.22724	.75	3.24843	.29	3.26919
.69	3.20640	.22	3.22764	.76	3.24882		
		.23	3.22803	.77	3.24921	26.30	3.26957
24.70	3.20680	.24	3.22843	.78	3.24960	.31	3.26995
.71	3.20721	.25	3.22883	.79	3.24999	.32	3.27033
.72	3.20761	.26	3.22922			.33	3.27071
.73	3.20802	.27	3.22962	25.80	3.25037	.34	3.27109
.74	3.20842	.28	3.23001	.81	3.25076	.35	3.27147
.75	3.20883	.29	3.23041	.82	3.25115	.36	3.27185
.76	3.20923			.83	3.25154	.37	3.27223
.77	3.20963	25.30	3.23080	.84	3.25192	.38	3.27261
.78	3.21004	.31	3.23120	.85	3.25231	.39	3.27299
.79	3.21044	.32	3.23159	.86	3.25270		
		.33	3.23199	.87	3.25308	26.40	3.27336
24.80	3.21084	.34	3.23238	.88	3.25347	.41	3.27374
.81	3.21125	.35	3.23278	.89	3.25386	.42	3.27412
.82	3.21165	.36	3.23317			.43	3.27450
.83	3.21205	.37	3.23357	25.90	3.25424	.44	3.27488
.84	3.21246	.38	3.23396	.91	3.25463	.45	3.27526
.85	3.21286	.39	3.23436	.92	3.25502	.46	3.27563
.86	3.21326			.93	3.25540	.47	3.27601
.87	3.21366	25.40	3.23475	.94	3.25579	.48	3.27639
.88	3.21406	.41	3.23514	.95	3.25617	.49	3.27677
.89	3.21447	.42	3.23554	.96	3.25656		
		.43	3.23593	.97	3.25794	26.50	3.27714
24.90	3.21487	.44	3.23632	.98	3.25733	.51	3.27752
.91	3.21527	.45	3.23672	.99	3.25771	.52	3.27790
.92	3.21567	.46	3.23711			.53	3.27828
.93	3.21607	.47	3.23750	26.00	3.25810	.54	3.27865
.94	3.21647	.48	3.23789	.01	3.25848	.55	3.27903
.95	3.21687	.49	3.23829	.02	3.25887	.56	3.27941
.96	3.21727			.03	3.25925	.57	3.27978
.97	3.21768	25.50	3.23868	.04	3.25963	.58	3.28016
.98	3.21808	.51	3.23907	.05	3.26002	.59	3.28054
.99	3.21848	.52	3.23946	.06	3.26040		
		.53	3.23985	.07	3.26079	26.60	3.28091
25.00	3.21888	.54	3.24025	.08	3.26117	.61	3.28129
.01	3.21928	.55	3.24064	.09	3.26155	.62	3.28166
.02	3.21968	.56	3.24103			.63	3.28104
.03	3.22008	.57	3.24142	26.10	3.26194	.64	3.28141
.04	3.22047	.58	3.24181	.11	3.26232	.65	3.28179
.05	3.22087	.59	3.24220	.12	3.26270	.66	3.28316
.06	3.22127			.13	3.26308	.67	3.28354
.07	3.22167	25.60	3.24259	.14	3.26347	.68	3.28391
.08	3.22207	.61	3.24298	.15	3.26385	.69	3.28429
.09	3.22247	.62	3.24337	.16	3.26423		
		.63	3.24376	.17	3.26461	26.70	3.28466
25.10	3.22287	.64	3.24415	.18	3.26500	.71	3.28504
.11	3.22327	.65	3.24454	.19	3.26538	.72	3.28541
.12	3.22366	.66	3.24493			.73	3.28579
.13	3.22406	.67	3.24532	26.20	3.26576	.74	3.28616
.14	3.22446	.68	3.24571	.21	3.26614	.75	3.28653
.15	3.22486	.69	3.24610	.22	3.26652	.76	3.28691
.16	3.22526			.23	3.26690	.77	3.28728
.17	3.22565	25.70	3.24649	.24	3.26729	.78	3.28766
.18	3.22605	.71	3.24688	.25	3.26767	.79	3.28803

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log$_e$	No.	Log$_e$	No.	Log$_e$	No.	Log$_e$
26.80	3.28840	27.34	3.30835	27.88	3.32791	28.41	3.34674
.81	3.28878	.35	3.30872	.89	3.32827	.42	3.34709
.82	3.28915	.36	3.30908			.43	3.34745
.83	3.28952	.37	3.30945	27.90	3.32863	.44	3.34780
.84	3.28989	.38	3.30981	.91	3.32899	.45	3.34815
.85	3.29027	.39	3.31018	.92	3.32934	.46	3.34850
.86	3.29064			.93	3.32970	.47	3.34885
.87	3.29101	27.40	3.31054	.94	3.33006	.48	3.34920
.88	3.29138	.41	3.31091	.95	3.33042	.49	3.34955
.89	3.29175	.42	3.31127	.96	3.33078		
		.43	3.31164	.97	3.33113	28.50	3.34990
26.90	3.29213	.44	3.31200	.98	3.33149	.51	3.35026
.91	3.29250	.45	3.31237	.99	3.33185	.52	3.35061
.92	3.29287	.46	3.31273			.53	3.35096
.93	3.29324	.47	3.31309	28.00	3.33220	.54	3.35131
.94	3.29361	.48	3.31346	.01	3.33256	.55	3.35166
.95	3.29398	.49	3.31382	.02	3.33292	.56	3.35201
.96	3.29435			.03	3.33328	.57	3.35236
.97	3.29473	27.50	3.31419	.04	3.33363	.58	3.35271
.98	3.29510	.51	3.31455	.05	3.33399	.59	3.35306
.99	3.29547	.52	3.31491	.06	3.33435		
		.53	3.31528	.07	3.33470	28.60	3.35341
27.00	3.29584	.54	3.31564	.08	3.33506	.61	3.35376
.01	3.29621	.55	3.31600	.09	3.33541	.62	3.35411
.02	3.29658	.56	3.31637			.63	3.35446
.03	3.29695	.57	3.31673	28.10	3.33577	.64	3.35480
.04	3.29732	.58	3.31709	.11	3.33613	.65	3.35515
.05	3.29769	.59	3.31745	.12	3.33648	.66	3.35550
.06	3.29806			.13	3.33684	.67	3.35585
.07	3.29843	27.60	3.31782	.14	3.33719	.68	3.35620
.08	3.29880	.61	3.31818	.15	3.33755	.69	3.35655
.09	3.29916	.62	3.31854	.16	3.33790		
		.63	3.31890	.17	3.33826	28.70	3.35690
27.10	3.29953	.64	3.31926	.18	3.33861	.71	3.35725
.11	3.29990	.65	3.31963	.19	3.33897	.72	3.35759
.12	3.30027	.66	3.31999			.73	3.35794
.13	3.30064	.67	3.32035	28.20	3.33932	.74	3.35829
.14	3.30101	.68	3.32071	.21	3.33968	.75	3.35864
.15	3.30138	.69	3.32107	.22	3.34003	.76	3.35899
.16	3.30174			.23	3.34039	.77	3.35933
.17	3.30211	27.70	3 32143	.24	3.34074	.78	3.35968
.18	3.30248	.71	3.32179	.25	3.34109	.79	3.36003
.19	3.30285	.72	3.32215	.26	3.34145		
		.73	3.32252	.27	3.34180	28.80	3.36038
27.20	3.30322	.74	3.32288	.28	3.34216	.81	3.36072
.21	3.30358	.75	3.32324	.29	3.34251	.82	3.36107
.22	3.30395	.76	3.32360			.83	3.36142
.23	3.30432	.77	3.32396	28.30	3.34286	.84	3.36176
.24	3.30469	.78	3.32432	.31	3.34322	.85	3.36211
.25	3.30505	.79	3.32468	.32	3.34357	.86	3.36246
.26	3.30542			.33	3.34392	.87	3.36280
.27	3.30579	27.80	3.32504	.34	3.34427	.88	3.36315
.28	3.30615	.81	3.32540	.35	3.34463	.89	3.36350
.29	3.30652	.82	3.32576	.36	3.34498		
		.83	3.32611	.37	3.34533	28.90	3.36384
27.30	3.30689	.84	3.32647	.38	3.34568	.91	3.36419
.31	3.30725	.85	3.32683	.39	3.34604	.92	3.36453
.32	3.30762	.86	3.32719			.93	3.36488
.33	3.30799	.87	3.32755	28.40	3.34639	.94	3.36522

HYPERBOLIC LOGARITHMS.—*Concluded.*

No.	Log*e*,	No.	Log*e*,	No.	Log*e*,	No.	Log*e*,
28.95	3.36557	29.22	3.37485	29.50	3.38439	29.77	3.39350
.96	3.36592	.23	3.37520	.51	3.38473	.78	3.39384
.97	3.36626	.24	3.37554	.52	3.38507	.79	3.39417
.98	3.36661	.25	3.37588	.53	3.38541		
.99	3.36695	.26	3.37622	.54	3.38575	29.80	3.39451
		.27	3.37656	.55	3.38608	.81	3.39484
29.00	3.36730	.28	3.37690	.56	3.38642	.82	3.39518
.01	3.36764	.29	3.37725	.57	3.38676	.83	3.39551
.02	3.36799			.58	3.38710	.84	3.39585
.03	3.36833	29.30	3.37759	.59	3.38744	.85	3.39619
.04	3.36867	.31	3.37793			.86	3.39652
.05	3.36902	.32	3.37827	29.60	3.38777	.87	3.39685
.06	3.36936	.33	3.37861	.61	3.38811	.88	3.39719
.07	3.36971	.34	3.37895	.62	3.38845	.89	3.39752
.08	3.37005	.35	3.37929	.63	3.38879		
.09	3.37039	.36	3.37963	.64	3.38912	29.90	3.39786
		.37	3.37997	.65	3.38946	.91	3.39819
29.10	3.37074	.38	3.38031	.66	3.38980	.92	3.39853
.11	3.37108	.39	3.38065	.67	3.39014	.93	3.39886
.12	3.37143			.68	3.39047	.94	3.39920
.13	3.37177	29.40	3.38099	.69	3.39081	.95	3.39953
.14	3.37211	.41	3.38133			.96	3.39986
.15	3.37246	.42	3.38167	29.70	3.39115	.97	3.40020
.16	3.37280	.43	3.38201	.71	3.39148	.98	3.40053
.17	3.37314	.44	3.38235	.72	3.39182	.99	3.40086
.18	3.37348	.45	3.38269	.73	3.39216		
.19	3.37383	.46	3.38303	.74	3.39249	30.00	3.40120
		.47	3.38337	.75	3.39283		
29.20	3.37417	.48	3.38371	.76	3.39317		
.21	3.37451	.49	3.38405				

TABLE OF ENGINE CONSTANTS.

A × 1000 + 33000 = Constant. Log. 33000 = 4.51851.

Diam. of Piston. Inches.	Area.	Log. of Area.	Constant for one foot.	Constant for 100 feet.	Constant for 1000 feet.	Log. of 1000 feet.
6	28.274	1.45139	.0008568	.08568	.85680	−1.93288
¼	30.679	1.48684	.00092968	.092968	.92968	−1.96833
½	33.183	1.52092	.00100556	.100556	1.00556	0.00241
¾	35.784	1.55369	.00108437	.108437	1.08437	0.03518
7	38.484	1.58528	.00116628	.116628	1.16628	0.06677
¼	41.282	1.61576	.00125098	.125098	1.25098	0.09725
½	44.178	1.64521	.00133876	.133876	1.33876	0.12670
¾	47.173	1.67369	.00142948	.142948	1.42948	0.15518
8	50.265	1.70127	.00152321	.152321	1.52321	0.18276
¼	53.456	1.72800	.00161991	.161991	1.61991	0.20949
½	56.745	1.75393	.00171957	.171957	1.71957	0.23542
¾	60.132	1.77911	.00182221	.182221	1.82221	0.26060
9	63.617	1.80357	.00192780	.192780	1.92780	0.28506
¼	67.200	1.82737	.0020364	.203640	2.03640	0.30886
½	70.882	1.85054	.00214800	.214800	2.14800	0.33203
¾	74.662	1.87310	.00226250	.226250	2.26250	0.35459
10	78.540	1.89509	.00238000	.238000	2.38000	0.37658
¼	82.516	1.91654	.00250040	.250040	2.50040	0.39800
½	86.590	1.93747	.00262400	.262400	2.62400	0.41896
¾	90.762	1.95790	.00275036	.275036	2.75036	0.43939
11	95.033	1.97787	.00287980	.287980	2.87980	0.45936
¼	99.402	1.99740	.00301224	.301224	3.01224	0.47889
½	103.86	2.01645	.00314731	.314731	3.14731	0.49794
¾	108.43	2.03515	.0032858	.32858	3.2858	0.51664
12	113.09	2.05342	.0034270	.34270	3.42700	0.53491
¼	117.85	2 07133	.00357125	.357125	3.57125	0.55282
½	122.71	2.08888	.00371852	.371852	3.71852	0.57037
¾	127.67	2.10609	.00386883	.386883	3.86883	0.58758
13	132.73	2.12297	.00402216	.402216	4.02216	0.60446
¼	137.88	2.13950	.0041782	.417820	4.17820	0.62099
½	143.13	2.15573	.0043373	.433730	4.33730	0.63722
¾	148.48	2.17167	.00449935	.449935	4.49935	0.65316
14	153.93	2.18732	.00466455	.466455	4.66455	0.66881
¼	159.48	2.20271	.00483281	.483281	4.83281	0.68420
½	165.13	2.21783	.00500403	.500403	5.00403	0.69932
¾	170.87	2.23267	.00517797	.517797	5.17797	0.71416
15	176.71	2.24726	.00535488	.535488	5.35488	0.72875
¼	182.65	2.26162	.00553490	.553490	5.53490	0.74311
½	188.69	2.27575	.00571794	.571794	5.71794	0.75724
¾	194.82	2.28963	.00590364	.590364	5.90364	0.77112
16	201.06	2.30333	.00609284	.609284	6.09284	0.78842
¼	207.39	2.31679	.00628463	.628463	6.28463	0.79828
½	213.82	2.33005	.00647948	.647948	6.47948	0.81154
¾	220.35	2.34311	.00667728	.667728	6.67727	0.82460
17	226.98	2.35599	.00687828	.687828	6.87828	0.83748
¼	233.70	2.36866	.00708190	.708190	7.08190	0.85015
½	240.52	2.38115	.00728853	.728853	7.28853	0.86264
¾	247.45	2.39349	.00749860	.749860	7.49860	0.87498
18	254.46	2.40562	.00771100	.771100	7.71100	0.88711
¼	261.58	2.41760	.00792665	.792665	7.92665	0.89909
½	268.80	2.42943	.00814554	.814554	8.14554	0.91092
¾	276.11	2.44108	.00836700	.836700	8.36700	0.92257
19	283.52	2.45258	.00859152	.859152	8.59152	0.93407
¼	291.03	2.46394	.00881921	.881921	8.81921	0.94543
½	298.64	2.47515	.00904982	.904982	9.04982	0.95664
¾	306.35	2.48622	.00928346	.928346	9.28346	0.96771

TABLE OF ENGINE CONSTANTS.—*Continued.*

Diam. of Piston. Inches.	Area.	Log. of Area.	Constant for one foot.	Constant for 100 feet.	Constant for 1000 feet.	Log. of 1000 feet.
20	314.16	2.49715	.00952007	.952007	9.52007	0.97864
¼	322.06	2.50794	.00975955	.975955	9.75955	0.98943
½	330.06	2.51859	.01000018	1.000018	10.00018	1.00008
¾	338.16	2.52912	.01024710	1.024710	10.24710	1.01061
21	346.36	2.53953	.01049600	1.049600	10.49600	1.02102
¼	354.65	2.54980	.01074710	1.074710	10.74710	1.03129
½	363.05	2.55997	.01100170	1.100170	11.00170	1.04146
¾	371.54	2.57001	.01125900	1.125900	11.25900	1.05150
22	380.13	2.57993	.01151910	1.151910	11.51910	1.06142
¼	388.82	2.58975	.01178250	1.178250	11.78250	1.07124
½	397.60	2.59945	.01204870	1.204870	12.04870	1.08094
¾	406.49	2.60905	.01231800	1.231800	12.31800	1.09054
23	415.47	2.61854	.01259010	1.259010	12.59010	1.10003
¼	424.55	2.62793	.01286530	1.286530	12.8653	1.10942
½	433.73	2.63722	.01314340	1.314340	13.14340	1.11871
¾	443.01	2.64641	.01342450	1.342450	13.42450	1.12790
24	452.39	2.65551	.01370900	1.370900	13.70900	1.13700
¼	461.86	2.66451	.01399600	1.399600	13.99600	1.14600
½	471.43	2.67342	.01428600	1.428600	14.28600	1.15491
¾	481.10	2.68224	.01457910	1.457910	14.57910	1.16373
25	490.87	2.69097	.01487510	1.487510	14.87510	1.17246
¼	500.74	2.69961	.01517400	1.517400	15.17400	1.18110
½	510.70	2.70817	.01547600	1.547600	15.47600	1.18966
¾	520.76	2.71664	.01578050	1.578050	15.78050	1.19813
26	530.93	2.72504	.01608900	1.608900	16.08900	1.20653
¼	541.18	2.73334	.01639950	1.639950	16.39950	1.21483
½	551.54	2.74158	.01671360	1.671360	16.71360	1.22307
¾	562.00	2.74974	.01703060	1.703060	17.03060	1.23123
27	572.55	2.75781	.0173500	1.73500	17.35000	1.23930
¼	583.20	2.76582	.0176730	1.767300	17.67300	1.24731
½	593.95	2.77375	.0179986	1.799860	17.99860	1.25524
¾	604.80	2.78161	.0183274	1.832740	18.32740	1.26310
28	615.75	2.78940	.01865910	1.865910	18.65910	1.27089
¼	626.79	2.79712	.01899370	1.899370	18.99370	1.27861
½	637.94	2.80478	.01933170	1.933170	19.33170	1.28627
¾	649.18	2.81237	.01967251	1.967251	19.67251	1.29386
29	660.52	2.81989	.02001620	2.001620	20.01620	1.30138
¼	671.95	2.82734	.02036240	2.036240	20.36240	1.30883
½	683.49	2.83473	.02071190	2.071190	20.71190	1.31622
¾	695.12	2.84206	.0210644	2.10644	21.0644	1.32355
30	706.86	2.84933	.02142000	2.142000	21.42000	1.33082
¼	718.69	2.85654	.02177860	2.177860	21.77860	1.33803
½	730.61	2.86369	.02214010	2.214010	22.14010	1.34518
¾	742.64	2.87078	.02250450	2.250450	22.50450	1.35227
31	754.76	2.87781	.02287120	2.287120	22.87120	1.35930
¼	766.99	2.88479	.02324230	2.324230	23.24230	1.36628
½	779.31	2.89171	.023615650	2.3615650	23.61565	1.37320
¾	791.73	2.89858	.02399220	2.399220	23.99220	1.38007
32	804.24	2.90539	.02437140	2.437140	24.37140	1.38688
¼	816.86	2.91215	.02475370	2.475370	24.75370	1.39364
½	829.57	2.91885	.02513852	2.513852	25.13852	1.40034
¾	842.39	2.92551	.02552700	2.552700	25.52700	1.40700
33	855.30	2.93212	.02591850	2.591850	25.91850	1.41361
¼	868.30	2.93867	.02631237	2.631237	26.31237	1.42016
½	881.41	2.94518	.02670976	2.670976	26.70976	1.42667
¾	894.61	2.95163	.02710940	2.710940	27.10940	1.43312
34	907.92	2.95805	.02751310	2.751310	27.51310	1.43954
¼	921.32	2.96441	.02791900	2.791900	27.91900	1.44590

TABLE OF ENGINE CONSTANTS.—*Continued.*

Diam. of Piston. Inches.	Area.	Log. of Area.	Constant for one foot.	Constant for 100 feet.	Constant for 1000 feet.	Log. of 1000 feet.
34½	934.82	2.97073	.02832820	2.832820	28.32820	1.45222
¾	948.41	2.97700	.02874020	2.874020	28.74020	1.45849
35	962.11	2.98322	.02915480	2.915480	29.15480	1.46471
¼	975.90	2.98941	.02957330	2.957330	29.57330	1.47090
½	989.80	2.99555	.02999440	2.999440	29.99440	1.47704
¾	1003.70	3.00160	.030415180	3.0415180	30.41518	1.48309
36	1017.80	3.00766	.03084251	3.084251	30.84251	1.48915
¼	1032.00	3.01368	.03127308	3.127308	31.27308	1.49517
½	1046.30	3.01966	.031706610	3.1706610	31.70661	1.50115
¾	1060.70	3.02559	.03214252	3.214252	32.14252	1.50708
37	1075.20	3.03149	.03258219	3.258219	32.58219	1.51298
½	1104.40	3.04313	.03346720	3.346720	33.46720	1.52462
38	1134.10	3.05465	.03436689	3.436689	34.36689	1.53614
½	1164.10	3.06599	.03527609	3.527609	35.27609	1.54748
39	1194.50	3.07719	.03619762	3.619762	36.19762	1.55868
½	1225.40	3.08828	.03713388	3.713388	37.13388	1.56977
40	1256.60	3.09920	.03807941	3.807941	38.07941	1.58069
½	1288.20	3.10998	.03903641	3.903641	39.03641	1.59147
41	1320.20	3.12064	.04000641	4.000641	40.00641	1.60213
½	1352.60	3.13117	.04098831	4.098831	40.98831	1.61265
42	1385.40	3.14158	.04198263	4.198263	41.98263	1.62307
½	1418.60	3.15186	.04298828	4.298828	42.98828	1.63335
43	1452.20	3.16203	.04400682	4.400682	44.00682	1.64352
½	1486.10	3.17205	.04503392	4.503392	45.03392	1.65354
44	1520.50	3.18199	.04607650	4.607650	46.07650	1.66348
½	1555.20	3.19179	.04712810	4.712810	47.12810	1.67328
45	1590.40	3.20151	.04819478	4.819478	48.19478	1.68300
½	1625.90	3.21109	.0492697	4.92697	49.2697	1.69258
46	1661.90	3.22060	.0503605	5.03605	50.3605	1.70209
½	1698.20	3.22999	.0514612	5.14612	51.4612	1.71148
47	1734.90	3.23927	.0525726	5.25726	52.5726	1.72076
½	1772.00	3.24846	.0536970	5.36970	53.6970	1.72995
48	1809.50	3.25756	.0548340	5.48340	54.8340	1.73905
½	1847.40	3.26656	.0559822	5.59822	55.9822	1.74805
49	1885.70	3.27547	.0571426	5.71426	57.1426	1.75696
½	1924.40	3.28430	.0583163	5 83163	58.3163	1.76579
50	1963.50	3.29303	.0595004	5.95004	59.5004	1.77452
½	2002.90	3.30166	.0606945	6.06945	60.6945+	1.78315
51	2042.80	3.31023	.0619042	6.19042	61.9042	1.79172
½	2083.00	3.31869	.0631218	6.31218	63.1218+	1.80018
52	2123.70	3.32709	.0643546	6.43546	64.3546	1.80858
½	2164.70	3.33540	.0655979	6.55979	65.5979	1.81689
53	2206.10	3.34303	.0668528	6.68528	66.8528	1.82512
½	2248.00	3.35180	.0681224	6.81224	68.1224	1.83329
54	2290.20	3.35984	.0693953	6.93953	69.3953	1.84133
½	2332.80	3.36788	.0706919	7.06919	70.6919	1.84937
55	2375.80	3.37581	.0719946	7.19946	71.9946	1.85730
½	2419.20	3.38367	.0733094	7.33094	73.3094	1.86516
56	2463.00	3.39146	.0746362	7.46362	74.6362	1.87295
½	2507.10	3.39917	.0759731	7.59731	75.9731	1.88066
57	2551.70	3.40683	.0773250	7.73250	77.3250	1.88832
½	2596.70	3.41442	.0786882	7.86882	78.6882	1.89591
58	2642.00	3.42193	.0800608	8.00608	80.0608	1.90342
½	2687.80	3.42940	.0814497	8.14497	81.4497	1.91089
59	2733.90	3.43678	.0828457	8.28457	82.8457	1.91827
½	2780.50	3.44412	.0842558	8.42558	84.2558	1.92561
60	2827.40	3.45139	.0856801	8.56801	85.6801	1.93288
½	2874.76	3.45860	.0871150	8.71150	87.1150	1.94009

TABLE OF ENGINE CONSTANTS.—*Concluded.*

Diam. of Piston. Inches.	Area.	Log. of Area.	Constant for one foot.	Constant for 100 feet.	Constant for 1000 feet.	Log. of 1000 feet.
61	2922.47	3.46575	.0885605	8.85605	88.5605	1.94724
62	3019.08	3.47987	.0914871	9.14871	91.4871	1.96136
63	3117.25	3.49377	.0944626	9.44626	94.4626	1.97526
64	3217.0	3.50745	.0974855	9.74855	97.4855	1.98894
65	3318.31	3.52092	.1005542	10.05542	100.5542	2.00241
66	3421.20	3.53418	.1036740	10.36740	103.6740	2.01567
67	3525.66	3.54724	.1068392	10.68392	106.8392	2.02873
68	3631.69	3.56011	.1100525	11.00525	110.0525	2.04160
69	3739.29	3.57279	.1133131	11.33131	113.3131	2.05428
70	3848.46	3.58529	.1166218	11.66218	116.6218	2.06678
71	3959.20	3.59761	.1199777	11.99777	119 9777	2.07910
72	4071.51	3.60975	.1233788	12.33788	123.3788	2.09124
73	4185.39	3.62174	.1268323	12.68323	126.8323	2.10323
74	4300.84	3.63356	.1303318	13.03318	130.3318	2.11505
75	4417.87	3.64522	.1138752	13.38752	133.8752	2.12671
76	4536.47	3.65672	.1374708	13.74708	137.4708	2.13821
77	4656.64	3.66807	.1411108	14.11108	141.1108	2.14955
78	4778.37	3.67928	.1448005	14.48005	144.8005	2.16077
79	4901.68	3.69035	.1485388	14.85388	148.5388	2.17184
80	5026.56	3.70127	.1523215	15.23213	152.3213	2.18276
81	5153.01	3.71206	.1561528	15.61528	156.1528	2.19355
82	5281.03	3.72272	.1600332	16.00332	160.0332	2.20421
83	5410.62	3.73325	.1639609	16.39609	163.9609	2.21474
84	5541.78	3.74365	.1679343	16.79343	167.9343	2.22514
85	5674.51	3.75393	.1719570	17.19570	171.9570	2.23542
86	5808.82	3.76409	.1760272	17.60272	176.0272	2.24558
87	5944.69	3.77413	.1801441	18.01441	180.1441	2.25562
88	6082.14	3.78405	.1843630	18.43630	184.3630	2.26554
89	6221.15	3.79387	.188521	18.8521	188.5210	2.27536
90	6361.74	3.80357	.192780	19.2780	192.7800	2.28506
91	6503.90	3.81317	.197090	19.7090	197.0900	2.29466
92	6647.63	3.82266	.201440	20.1440	201.4400	2.30415
93	6792.92	3.83206	.205850	20.5850	205.850	2.31355
94	6939.79	3.84135	.210300	21.0300	210.300	2.32284
95	7088.24	3.85054	.214800	21.4800	214.800	2.33203
96	7238.25	3.85963	.219340	21.9340	219.340	2.34112
97	7389.83	3.86863	.22393	22.3930	223.930	2.35012
98	7542.98	3.87754	.22857	22.8570	228.570	2.35903
99	7697.71	3.88636	.23327	23.3270	233.270	2.36785
100	7854.00	3.89509	.238000	23.8000	238.000	2.37658
101	8011.87	3.90373	.242790	24.2790	242.790	2.38522
102	8171.30	3.91229	.247610	24.7610	247.610	2.39378
103	8332.31	3.92076	.252490	25.2490	252.490	2.40225
104	8494.89	3.92916	.257430	25.7430	257.430	2.41065
105	8659.03	3.93747	.262400	26.2400	262.400	2.41896
106	8824.75	3.94570	.267420	26.7420	267.420	2.42719
107	8992.04	3.95386	.272490	27.2490	272.490	2.43535
108	9160.91	3.96194	.277610	27.7610	277.610	2.44343
109	9331.34	3.96994	.282760	28.2760	282.760	2.45143
110	9503.34	3.97768	.287990	28.7990	287.990	2.45937
111	9676.91	3.98574	.293250	29.3250	293.250	2.46723
112	9852.06	3.99353	.298550	29.8550	298.550	2.47502
113	10028.77	4.00126	.303910	30.3910	303.910	2.48275
114	10207.06	4.00890	.309310	30.9310	309.310	2.49039
115	10386.91	4.01649	.314760	31.4760	314.760	2.49798
116	10568.34	4.02411	.320260	32.0260	320.260	2.50550
117	10751.34	4.03146	.325806	32.5806	325.806	2.51296

TABLE OF THE PRESSURE, TEMPERATURE, VOLUME AND DENSITY OF SATURATED STEAM.

Col. 1.—Absolute Pressure.
" 2.—Steam Gauge Pressure.
" 3.—Temperature at Pressure, in F°.
" 4.—Specific Volume, or Cubic Feet in a Pound.
" 5.—Log. of Specific Volume.

Col. 6.—Weight of One Cubic Foot, or Density, in Pounds.
" 7.—Log. of Density, —10.
" 8.—Relative Volume or Cubic Feet, from One Cubic Foot Water.
" 9.—Log. of Relative Volume.

1	2	3	4	5	6	7	8	9
						−10,		
1	−13.7	102.041	319.600	2.50461	.0031289	7.49539	19951.20	4.29997
2	−12.7	126.310	172.417	2.23658	.005799	7.76342	10763.21	4.03194
3	−11.7	141.628	117.723	2.07086	.0084946	7.92914	7348.90	3.86622
4	−10.7	153.066	89.799	1.95327	.011136	8.04673	5605.70	3.74863
5	− 9.7	162.337	72.792	1.86208	.013738	8.13792	4544.00	3.65744
6	− 8.7	170.132	61.311	1.78754	.016318	8.21246	3827.40	3.58290
7	− 7.7	176.929	53.000	1.72428	.018868	8.27572	3308.60	3.51964
8	− 6.7	182.919	46.771	1.66998	.021381	8.33002	2919.70	3.46534
9	− 5.7	188.326	41.858	1.62178	.023820	8.37822	2613.00	3.41714
10	− 4.7	193.301	37.904	1.57868	.026383	8.42132	2366.16	3.37404
11	− 3.7	197.769	34.659	1.53981	.028853	8.46019	2163.60	3.33517
12	− 2.7	201.958	31.932	1.50423	.031316	8.49577	1993.40	3.29959
13	− 1.7	205.889	29.593	1.47118	.033793	8.52882	1847.32	3.26654
14	− .7	209.610	27.624	1.44128	.036201	8.55872	1724.40	3.23664
14.7.	.0	212.000	26.360	1.42095	.037936	8.57905	1645.55	3.21631
15	+ .3	213.036	25.858	1.41260	.038672	8.58740	1614.21	3.20796
16	1.3	216.298	24.335	1.38622	.041094	8.61378	1519.10	3.18158
17	2.3	219.428	22.985	1.36144	.043507	8.63856	1434.83	3.15680
18	3.3	222.414	21.781	1.33808	.045911	8.66192	1359.70	3.13344
19	4.3	225.213	20.701	1.31598	.048308	8.68402	1292.20	3.11134
20	5.3	227.919	19.725	1.29501	.050698	8.70499	1231.32	3.09037
21	6.3	230.511	18.839	1.27507	.053080	8.72493	1176.10	3.07043
22	7.3	233.014	18.033	1.25606	.055455	8.74394	1125.70	3.05142
23	8.3	235.433	17.293	1.23788	.057826	8.76212	1079.60	3.03324
24	9.3	237.757	16.615	1.22049	.060188	8.77951	1037.20	3.01585
25	10.3	240.070	15.988	1.20380	.062546	8.79620	998.07	2.99916
26	11.3	242.185	15.409	1.18778	.064896	8.81222	961.93	2.98314
27	12.3	244.289	14.871	1.17235	.067244	8.82765	928.35	2.96771
28	13.3	246.336	14.371	1.15748	.069586	8.84252	897.10	2.95284
29	14.3	248.316	13.904	1.14313	.071924	8.85687	867.94	2.93849
30	15.3	250.254	13.467	1.12928	.074254	8.87072	840.70	2.92464
31	16.3	252.118	13.058	1.11588	.076581	8.88412	815.16	2.91124
32	17.3	253.942	12.674	1.10290	.078905	8.89710	791.16	2.89826
33	18.3	255.726	12.312	1.09032	.081224	8.90968	768.57	2.88568
34	19.3	257.470	11.971	1.07812	.083537	8.92188	747.28	2.87348
35	20.3	259.172	11.649	1.06627	.085848	8.93373	727.16	2.86163
36	21.3	260.829	11.344	1.05476	.088154	8.94524	708.14	2.85012
37	22.3	262.451	11.055	1.04358	.090453	8.95642	690.15	2.83894
38	23.3	264.039	10.756	1.03166	.092970	8.96834	671.47	2.82702
39	24.3	265.599	10.521	1.02204	.095052	8.97796	656.75	2.81740
40	25.3	267.124	10.259	1.01122	.097450	8.98878	640.59	2.80658
41	26.3	268.614	10.037	1.00160	.099633	8.99840	626.55	2.79696
42	27.3	270.071	9.8119	.99175	.101920	9.00825	612.51	2.78711
43	28.3	271.511	9.5968	.98212	.104200	9.01788	599.08	2.77748
44	29.3	272.921	9.3914	.97273	.106480	9.02727	586.26	2.76809
45	30.3	274.294	9.1966	.96363	.10873	9.03637	574.10	2.75899

PRESSURE, TEMPERATURE, ETC., OF STEAM.—*Continued.*

1	2	3	4	5	6	7	8	9
46	31.3	275.654	9.0066	.95456	.11103	—10, 9.04544	562.24	2.74992
47	32.3	276.995	8.8262	.94577	.11330	9.05423	550.97	2.74113
48	33.3	278.291	8.6531	.93717	.11557	9.06283	540.17	2.73253
49	34.3	279.584	8.4872	.92876	.11783	9.07124	529.81	2.72412
50	35.3	280.849	8.3268	.92048	.12009	9.07952	519.81	2.71584
51	36.3	282.104	8.1730	.91238	.12235	9.08762	510.20	2.70774
52	37.3	283.321	8.0251	.90445	.12461	9.09555	500.97	2.69981
53	38.3	284.535	7.8825	.89666	.12687	9.10334	492.06	2.69202
54	39.3	285.719	7.7450	.88902	.12911	9.11098	483.48	2.68438
55	40.3	286.896	7.6124	.88153	.13136	9.11847	475.21	2.67689
56	41.3	288.047	7.4844	.87416	.13361	9.12584	467.22	2.66952
57	42.3	289.114	7.3607	.86692	.13586	9.13308	459.49	2.66228
58	43.3	290.312	7.2412	.85981	.13810	0.14019	452.03	2.65517
59	44.3	291.421	7.1258	.85283	.14034	9.14717	444.83	2.64819
60	45.3	292.526	7.0139	.84596	.14257	9.15404	437.84	2.64132
61	46.3	293.594	6.9054	.83919	.14481	9.16081	431.07	2.63455
62	47.3	294.659	6.8008	.83256	.14704	9.16744	424.54	2.62792
63	48.3	295.710	6.6990	.82601	.14928	9.17399	418.19	2.62137
64	49.3	296.756	6.6006	.81958	.15150	9.18042	412.04	2.61494
65	50.3	297.779	6.5050	.81325	.15372	9.18675	406.08	2.60861
66	51.3	298.788	6.4121	.80700	.15595	9.19300	400.28	2.60236
67	52.3	299.791	6.3220	.80085	.15818	9.19915	394.65	2.59621
68	53.3	300.777	6.2345	.79480	.16040	9.20520	389.19	2.59016
69	54.3	301.756	6.1494	.78883	.16262	9.21117	383.88	2.58419
70	55.3	302.721	6.0667	.78295	.16484	9.21705	378.71	2.57831
71	56.3	303.673	5.9862	.77715	.16705	9.22285	373.69	2.57251
72	57.3	304.617	5.9079	.77143	.16927	9.22857	368.80	2.56679
73	58.3	305.552	5.8318	.76580	.17148	9.23420	364.05	2.56116
74	59.3	306.474	5.7576	.76024	.17368	9.23976	359.42	2.55560
75	60.3	307.388	5.6840	.75465	.17594	9.24535	354.82	2.55001
76	61.3	308.294	5.6143	.74933	.17810	9.25067	350.50	2.54469
77	62.3	309.186	5.5461	.74399	.18030	9.25601	346.22	2.53935
78	63.3	310.072	5.4792	.73872	.18251	9.26128	342.04	2.53408
79	64.3	310.945	5.4138	.73350	.18471	9.26650	337.96	2.52886
80	65.3	311.814	5.3423	.72773	.18718	9.27227	333.50	2.52309
81	66.3	312.672	5.2879	.72328	.18911	9.27672	330.09	2.51864
82	67.3	313.524	5.2273	.71828	.19130	9.28172	326.32	2.51364
83	68.3	314.359	5.1679	.71331	.19350	9.28669	322.61	2.50867
84	69.3	315.200	5.1100	.70842	.19569	9.29158	318.98	2.50378
85	70.3	316.009	5.0535	.70359	.19788	9.29641	315.45	2.49895
86	71.3	316.843	4.9982	.69881	.20007	9.30119	312.01	2.49417
87	72.3	317.651	4.9439	.69407	.20227	9.30593	308.63	2.48943
88	73.3	318.455	4.8910	.68940	.20446	9.31060	305.32	2.48476
89	74.3	319.252	4.8394	.68479	.20664	9.31521	302.10	2.48015
90	75.3	320.042	4.7887	.68022	.20882	9.31978	298.94	2.47558
91	76.3	320.819	4.7393	.67571	.21101	9.32429	295.85	2.47107
92	77.3	321.596	4.6907	.67124	.21318	9.32876	292.82	2.46660
93	78.3	322.369	4.6433	.66683	.21536	9.33317	289.86	2.46219
94	79.3	323.131	4.5965	.66245	.21755	9.33755	286.95	2.45781
95	80.3	323.887	4.5512	.65813	.21972	9.34187	284.11	2.45349
96	81.3	324.629	4.5066	.65385	.22190	9.34615	281.34	2.44921
97	82.3	325.382	4.4627	.64960	.22408	9.35040	278.59	2.44496
98	83.3	326.111	4.4199	.64541	.22625	9.35459	275.91	2.44077

PRESSURE, TEMPERATURE, ETC., OF STEAM.—*Continued.*

1	2	3	4	5	6	7	8	9
99	84.3	326.848	4.3778	.64126	.22843	—10. 9.35874	273.29	2.43662
100	85.3	327.576	4.3367	.63716	.23059	9.36284	270.72	2.43252
1	86.3	328.284	4.2962	.63308	.23277	9.36692	268.19	2.42844
2	87.3	329.002	4.2566	.62906	.23493	9.37094	265.72	2.42442
3	88.3	329.711	4.2175	.62506	.23711	9.37494	263.38	2.42042
4	89.3	330.423	4.1796	.62113	.23926	9.37887	260.91	2.41649
5	90.3	331.117	4.1421	.61722	.24143	9.38278	258.57	2.41258
6	91.3	331.814	4.1053	.61334	.24359	9.38666	256.27	2.40870
7	92.3	332.498	4.0691	.60950	.24576	9.39050	254.02	2.40486
8	93.3	333.177	4.0339	.60572	.24790	9.39428	251.82	2.40108
9	94.3	333.859	3.9988	.60193	.25008	9.39807	249.62	2.39729
110	95.3	334.528	3.9646	.59820	.25223	9.40180	247.49	2.39356
11	96.3	335.199	3.9311	.59451	.25439	9.40549	245.40	2.38987
12	97.3	335.857	3.8979	.59083	.25655	9.40917	243.33	2.38619
13	98.3	336.521	3.8654	.58719	.25871	9.41281	241.29	2.38255
14	99.3	337.166	3.8336	.58361	.26085	9.41639	239.32	2.37897
15	100.3	337.821	3.8022	.58003	.26301	9.41997	237.35	2.37539
16	101.3	338.462	3.7713	.57649	.26516	9.42351	235.43	2.37185
17	102.3	339.108	3.7409	.57298	.26731	9.42702	233.53	2.36834
18	103.3	339.733	3.7111	.56950	.26947	9.43050	231.66	2.36486
19	104.3	340.364	3.6818	.56606	.27161	9.43394	229.84	2.36142
120	105.3	340.991	3.6528	.56263	.27376	9.43737	228.03	2.35799
21	106.3	341.621	3.6244	.55924	.27591	9.44076	226.26	2.35460
22	107.3	342.242	3.5965	.55588	.27805	9.44412	224.51	2.35124
23	108.3	342.858	3.5689	.55253	.28020	9.44747	222.79	2.34789
24	109.3	343.468	3.5419	.54924	.28233	9.45076	221.11	2.34460
25	110.3	344.077	3.5151	.54594	.28449	9.45406	219.43	2.34130
26	111.3	344.673	3.4889	.54269	.28662	9.45731	217.80	2.33805
27	112.3	345.281	3.4631	.53947	.28876	9.46053	216.19	2.33483
28	113.3	345.877	3.4376	.53626	.29090	9.46374	214.60	2.33162
29	114.3	346.455	3.4125	.53307	.29304	9.46693	213.03	2.32843
130	115.3	347.056	3.3878	.52992	.29518	9.47008	211.49	2.32528
31	116.3	347.641	3.3634	.52678	.29732	9.47322	209.96	2.32214
32	117.3	348.229	3.3395	.52368	.29945	9.47632	208.47	2.31904
33	118.3	348.811	3.3159	.52060	.30158	9.47940	207.00	2.31596
34	119.3	349.388	3.2925	.51752	.30373	9.48248	205.53	2.31288
35	120.3	349.954	3.2695	.51448	.30586	9.48552	204.10	2.30984
36	121.3	350.523	3.2470	.51148	.30798	9.48852	202.69	2.30684
37	122.3	351.091	3.2246	.50848	.31011	9.49152	201.30	2.30384
38	123.3	351.755	3.2027	.50551	.31224	9.49449	199.93	2.30087
39	124.3	352.214	3.1809	.50255	.31438	9.49745	198.57	2.29791
140	125.3	352.766	3.1596	.49963	.31650	9.50037	197.24	2.29499
41	126.3	353.314	3.1385	.49672	.31863	9.50328	195.47	2.29208
42	127.3	353.866	3.1176	.49382	.32076	9.50618	194.62	2.28918
43	128.3	354.411	3.0971	.49095	.32289	9.50905	193.33	2.28631
44	129.3	354.958	3.0768	.48810	.32501	9.51190	192.07	2.28346
45	130.3	355.508	3.0569	.48528	.32713	9.51472	190.83	2.28064
46	131.3	356.031	3.0373	.48248	.32925	9.51752	189.60	2.27784
47	132.3	356.566	3.0178	.47969	.33137	9.52031	188.39	2.27505
48	133.3	357.111	2.9988	.47095	.33347	9 52305	187.20	2.27231
49	134.3	357.633	2.9800	.47421	.33558	9.52579	186.02	2.26957
150	135.3	358.166	2.9614	.47150	.33768	9.52850	184.87	2.26686

PRESSURE, TEMPERATURE, ETC., OF STEAM.—*Continued.*

1	2	3	4	5	6	7	8	9
						—10,		
151	136.3	358.688	2.9427	.46875	.33982	9.53125	183.70	2.26411
52	137.3	359.205	2.9244	.46604	.34195	9.53396	182.56	2.26140
53	138.3	359.722	2.9061	.46331	.34441	9.53669	181.41	2.25867
54	139.3	360.239	2.8884	.46066	.34621	9.53934	180.31	2.25602
55	140.3	360.744	2.8716	.45812	.34824	9.54188	179.26	2.25348
56	141.3	361.256	2.8537	.45541	.35042	9.54459	178.14	2.25077
57	142.3	361.762	2.8370	.45285	.35249	9.54715	177.10	2.24821
58	143.3	362.277	2.8198	.45021	.35464	9.54979	176.02	2.24557
59	144.3	362.776	2.8040	.44778	.35663	9.55222	175.04	2.24314
160	145.3	363.278	2.7878	.44526	.35871	9.55474	174.03	2.24062
61	146.3	363.777	2.7701	.44250	.36099	9.55750	172.93	2.23786
62	147.3	364.272	2.7558	.44024	.36288	9.55976	172.03	2.23560
63	148.3	364.771	2.7379	.43741	.36525	9.56259	170.91	2.23277
64	149.3	365.261	2.7225	.43497	.36731	9.56503	169.95	2.23033
65	150.3	365.739	2.7067	.43244	.36945	9.56756	168.97	2.22780
66	151.3	366.236	2.6914	.42998	.37156	9.57002	168.02	2.22534
67	152.3	366.721	2.6764	.42754	.37365	9.57246	167.07	2.22290
68	153.3	367.202	2.6618	.42518	.37568	9.57482	166.17	2.22054
69	154.3	367.684	2.6464	.42265	.37788	9.57735	165.20	2.21801
170	155.3	368.162	2.6333	.42045	.37980	9.57955	164.36	2.21581
71	156.3	368.636	2.6172	.41783	.38209	9.58217	163.38	2.21319
72	157.3	369.109	2.6035	.41555	.38411	9.58445	162.52	2.21091
73	158.3	369.576	2.5890	.41313	.38625	9.58687	161.62	2.20849
74	159.3	370.045	2.5751	.41079	.38834	9.58921	160.75	2.20615
75	160.3	370.514	2.5613	.40845	.39044	9.59155	159.89	2.20381
76	161.3	370.982	2.5473	.40608	.39257	9.59392	159.02	2.20144
77	162.3	371.448	2.5238	.40378	.39466	9.59622	158.18	2.19914
78	163.3	371.914	2.5215	.40165	.39660	9.59835	157.40	2.19701
79	164.3	372.367	2.5073	.39920	.39884	9.60080	156.52	2.19456
180	165.3	372.824	2.4943	.39695	.40091	9.60305	155.71	2.19231
81	166.3	373.277	2.4806	.39455	.40313	9.60545	154.85	2.18991
82	167.3	373.737	2.4686	.39245	.40509	9.60755	154.10	2.18781
83	168.3	374.188	2.4556	.39015	.40724	9.60985	153.29	2.18551
84	169.3	374.639	2.4432	.38795	.40931	9.61205	152.52	2.18331
85	170.3	375.088	2.4308	.38575	.41139	9.61425	151.74	2.18111
86	171.3	375.536	2.4185	.38355	.41348	9.61645	150.98	2.17891
87	172.3	375.978	2.4063	.38135	.41558	9.61865	150.21	2.17671
88	173.3	376.416	2.3942	.37915	.41769	9.62085	149.45	2.17451
89	174.3	376.843	2.3826	.37705	.41971	9.62295	148.73	2.17241
190	175.3	377.299	2.3705	.37485	.42184	9.62515	147.98	2.17021
91	176.3	377.729	2.3586	.37265	.42399	9.62735	147.23	2.16801
92	177.3	378.163	2.3472	.37055	.42604	9.62945	146.52	2.16591
93	178.3	378.591	2.3359	.36845	.42811	9.63155	145.82	2.16381
94	179.3	379.021	2.3241	.36625	.43028	9.63375	145.08	2.16161
95	180.3	379.457	2.3129	.36415	.43236	9.63585	144.38	2.15951
96	181.3	379.983	2.3022	.36215	.43436	9.63785	143.72	2.15751
97	182.3	380.310	2.2906	.35995	.43657	9.64005	142.99	2.15531
98	183.3	380.729	2.2795	.35785	.43777	9.64215	142.30	2.15321
99	184.3	381.160	2.2696	.35595	.44061	9.64405	141.68	2.15131
200	185.3	381.576	2.2536	.35385	.44274	9.64615	141.00	2.14921
1	186.3	381.994	2.2488	.35194	.44469	9.64806	140.39	2.14730
2	187.3	382.408	2.2385	.34995	.44674	9.65005	139.73	2.14531
3	188.3	382.821	2.2272	.34775	.44900	9.65225	139.03	2.14311

PRESSURE, TEMPERATURE, ETC., OF STEAM.—*Concluded.*

1	2	3	4	5	6	7	8	9
						−10,		
204	189.3	383.240	2.2169	.34575	.45108	9.65425	138.40	2.14111
5	190.3	383.660	2.2047	.34335	.45358	9.65665	137.63	2.13871
6	191.3	384.070	2.1966	.34175	.45525	9.65825	137.12	2.13711
7	192.3	384.480	2.1865	.33975	.45735	9.66025	136.49	2.13511
8	193.3	384.894	2.1769	.33785	.45936	9.66215	135.90	2.13321
9	194.3	385.287	2.1669	.33585	.46148	9.66415	135.27	2.13121
210	195.3	385.671	2.1570	.33385	.46361	9.66615	134.65	2.12921
11	196.3	386.122	2.1476	.33195	.46564	9.66805	134.06	2.12731
12	197.3	386.522	2.1387	.33015	.46757	9.66985	133.51	2.12551
13	198.3	386.922	2.1284	.32805	.46984	9.67195	132.86	2.12341
14	199.3	387.326	2.1191	.32615	.47190	9.67385	132.29	2.12151
15	200.3	387.724	2.1098	.32425	.47397	9.67575	131.71	2.11961
16	201.3	388.162	2.1011	.32245	.47594	9.67755	131.16	2.11781
17	202.3	388.512	2.0919	.32055	.47802	9.67945	130.59	2.11591
18	203.3	388.904	2.0828	.31865	.48012	9.68135	130.02	2.11401
19	204.3	389.196	2.0737	.31675	.48223	9.68325	129.45	2.11211
220	205.3	389.584	2.0647	.31485	.48434	9.68515	128.89	2.11021
21	206.3	390.071	2.0557	.31295	.48646	9.68705	128.33	2.10831
22	207.3	390.460	2.0476	.31125	.48837	9.68875	127.82	2.10661
23	208.3	390.858	2.0387	.30935	.49051	9.69065	127.27	2.10471
24	209.3	391.241	2.0303	.30755	.49255	9.69245	126 74	2.10291
25	210.3	391.633	2.0219	.30575	.49460	9.69425	126.22	2.10111
26	211.3	391.992	2.0131	.30385	.49676	9.69615	125.66	2.09921
27	212.3	392.390	2.0047	.30205	.49883	9.69795	125.14	2.09741
28	213.3	392.823	1.9964	.30025	.50090	9.69975	124.63	2.09561
29	214.3	393.156	1.9886	.29855	.50286	9.70145	124.14	2.09391
230	215.3	393.533	1.9800	.29665	.50507	9.70335	123.60	2.09201
31	216.3	393.913	1.9722	.29495	.50705	9.70505	123.12	2.09031
32	217.3	394.283	1.9641	.29315	.50916	9.70685	122.61	2.08851
33	218.3	394.662	1.9568	.29155	.51104	9.70845	122.16	2.08691
34	219.3	395.036	1.9483	.28965	.51328	9.71035	121.62	2.08501
35	220.3	395.405	1.9407	.28795	.51529	9.71205	121.15	2.08331
36	221.3	395.770	1.9326	.28615	.51743	9.71385	120.65	2.08151
37	222.3	396.141	1.9251	.28445	.51946	9.71555	120.17	2.07981
38	223.3	396.510	1.9171	.28265	.52162	9.71735	119 67	2.07801
39	224.3	396.888	1.9096	.28095	.52367	9.71905	119.21	2.07631
240	225.3	397.252	1.9022	.27925	.52572	9.72075	118.75	2.07461
41	226.3	397.612	1.8952	.27765	.52765	9.72235	118.31	2.07301
42	227.3	397.964	1.8873	.27585	.52985	9.72415	117.82	2.07121
43	228.3	398.340	1.8804	.27425	.53181	9.72575	117.39	2.06961
44	229.3	398.688	1.8727	.27245	.53401	9.72755	116.90	2.06781
45	230.3	399.061	1.8662	.27095	.53586	9.72905	116.50	2.06631
46	231.3	399.412	1.8589	.26925	.53796	9.73075	116.04	2.06461
47	232.3	399.762	1.8516	.26755	.54007	9.73245	115.59	2.06291
48	233.3	400.131	1.8447	.26595	.54206	9.73405	115.16	2.06131
49	234.3	400 482	1.8376	.26425	.54419	9.73575	114.71	2.05961
250	235.3	400.832	1.8309	.26265	.54620	9.73735	114.29	2.05801

REGNAULT'S RESULTS AT THE PARIS OBSERVATORY.

Degrees Centigrade.	Regnault's Record of Pressure in Millimetres at Observatory.	Log. of Millimetres.	Millimetres reduced to lbs. per square inch at 45° Latitude, and Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude, at Sea Level.	Equivalent of C° in Fahrenheit degrees.
40	54.906	1.7396198	1.061715	0.0260079	104.0
1	57.910	1.7627536	1.119830	0.0491417	105.8
2	61.055	1.7857212	1.180613	0.0721093	107.6
3	64.346	1.8085216	1.244257	0.0949097	109.4
4	67.790	1.8311656	1.310852	0.1175537	111.2
5	71.391	1.8536435	1.380485	0.1400316	113.0
6	75.158	1.8759752	1.453327	0.1623633	114.8
7	79.093	1.8981380	1.529424	0.1845261	116.6
8	83.204	1.9201442	1.608912	0.2065323	118.4
9	87.499	1.9420031	1.691964	0.2283912	120.2
50	91.982	1.9637028	1.778652	0.2500909	122.0
1	96.661	1.9852513	1.869130	0.2716394	123.8
2	101.543	2.0066499	1.963526	0.2930380	125.6
3	106.636	2.0279038	2.062015	0.3142919	127.4
4	111.945	2.0490047	2.164625	0.3353828	129.2
5	117.478	2.0699566	2.271660	0.3563447	131.0
6	123.244	2.0907658	2.383163	0.3771539	132.8
7	129.251	2.1114340	2.499370	0.3978221	134.6
8	135.505	2.1319553	2.620255	0.4183434	136.4
9	142.015	2.1523342	2.746137	0.4387223	138.2
60	148.791	2.1725766	2.877163	0.4589647	140.0
1	155.839	2.1926761	3.013450	0.4790642	141.8
2	163.170	2.2126403	3.155210	0.4990284	143.6
3	170.791	2.2324650	3.302577	0.5188531	145.4
4	178.714	2.2521586	3.355785	0.5385467	147.2
5	186.945	2.2717139	3.614947	0.5581020	149.0
6	195.496	2.2911379	3.780300	0.5775260	150.8
7	204.376	2.3104298	3.952010	0.5968179	152.6
8	213.596	2.3295931	4.130990	0.6159912	154.4
9	223.165	2.3485261	4.315330	0.6350142	156.2
70	233.093	2.3675292	4.507308	0.6539173	158.0
1	243.393	2.3863080	4.706480	0.6726962	159.8
2	254.073	2.4049585	4.912999	0.6913466	161.6
3	265.147	2.4234867	5.127135	0.7098748	163.4
4	276.624	2.4418899	5.349080	0.7282780	165.2
5	288.517	2.4601714	5.579040	0.7465595	167.0
6	300.838	2.4783327	5.817290	0.7647208	168.8
7	313.600	2.4963761	6.064070	0.7827642	170.6
8	326.811	2.5142966	6.319530	0.8006847	172.4
9	340.488	2.5321018	6.584000	0.8184899	174.2
80	354.643	2.5497914	6.857714	0.8361795	176.0
1	369.287	2.5673640	7.140887	0.8537521	177.8
2	384.435	2.5848229	7.433806	0.8712111	179.6
3	400.101	2.6021697	7.736740	0.8885578	181.4
4	416.298	2.6194043	8.049936	0.9057924	183.2
5	433.041	2.6365290	8.373694	0.9229171	185.0
6	450.344	2.6535443	8.708280	0.9399325	186.8
7	468.221	2.6704509	9.053970	0.9568390	188.6

REGNAULT'S RESULTS.—*Continued.*

Degrees Centigrade.	Regnault's Record of Pressure in Millimetres at Observatory.	Log. of Millimetres.	Millimetres reduced to lbs. per square inch at 45° Latitude, and Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude, at Sea Level.	Equivalent of C° in Fahrenheit degrees.
88	486.687	2.6872497	9.411045	0.9736378	190.4
9	505.759	2.7039436	9.779840	0.9903317	192.2
90	525.450	2.7205314	10.16060	1.0069195	194.0
1	545.778	2.7370160	10.55360	1.0234041	195.8
2	566.757	2.7533969	10.95925	1.0397850	197.6
3	588.406	2.7696771	11.37798	1.0560652	199.4
4	610.740	2.7858564	11.80984	1.0722445	201.2
5	633.778	2.8019372	12.25534	1.0883253	203.0
6	657.535	2.8179189	12.71473	1.1043070	204.8
7	682.029	2.8338029	13.18833	1.1201910	206.6
8	707.280	2.8495914	13.67665	1.1359795	208.4
9	733.305	2.8652847	14.17988	1.1516728	210.2
100	760.000	2.8808136	14.69609	1.1672017	212.0
1	787.590	2.8963002	15.22958	1.1826883	213.8
2	816.010	2.9116955	15.77916	1.1980836	215.6
3	845.280	2.9270006	16.34514	1.2133887	217.4
4	875.410	2.9422115	16.92775	1.2285996	219.2
5	906.410	2.9573247	17.52721	1.2437128	221.0
6	938.310	2.9723463	18.14405	1.2587344	222.8
7	971.140	2.9872818	18.77888	1.2736699	224.6
8	1004.910	3.0021271	19.43190	1.2885152	226.4
9	1039.650	3.0168872	20.10367	1.3032753	228.2
110	1075.370	3.0315579	20.79438	1.3179460	230.0
1	1112.090	3.0461400	21.50443	1.3325281	231.8
2	1149.830	3.0606336	22.23420	1.3470217	233.6
3	1188.610	3.0750394	22.98410	1.3614274	235.4
4	1228.470	3.0893646	23.75487	1.3757527	237.2
5	1269.410	3.1036019	24.54710	1.3899900	239.0
6	1311.470	3.1177584	25.35985	1.4041465	240.8
7	1354.660	3.1318304	26.19500	1.4182185	242.6
8	1399.020	3.1458239	27.05278	1.4322120	244.4
9	1444.550	3.1597326	27.93320	1.4461207	246.2
120	1491.280	3.1735592	28.83681	1.4599473	248.0
1	1539.250	3.1873092	29.76441	1.4736973	249.8
2	1588.470	3.2009790	30.71618	1.4873671	251.6
3	1638.960	3.2145683	31.69250	1.5009565	253.4
4	1690.760	3.2280820	32.69417	1.5144701	255.2
5	1743.880	3.2415166	33.72133	1.5279047	257.0
6	1798.350	3.2548742	34.77460	1.5412623	258.8
7	1854.200	3.2681566	35.85458	1.5545447	260.6
8	1911.470	3.2813675	36.96200	1.5677556	262.4
9	1970.150	3.2944993	38.09670	1.5808874	264.2
130	2030.280	3.3075559	39.25943	1.5939440	266.0
1	2091.940	3.3205492	40.45174	1.6069373	267.8
2	2155.030	3.3334534	41.67173	1.6198414	269.6
3	2219.690	3.3462923	42.92104	1.6326804	271.4
4	2285.920	3.3590610	44.20273	1.6454491	273.2
5	2353.730	3.3717567	45.51394	1.6581448	275.0

REGNAULT'S RESULTS.—*Continued.*

Degrees Centigrade.	Regnault's Record of Pressure in Millimetres at Observatory.	Log. of Millimetres.	Millimetres reduced to lbs. per square inch at 45° Latitude, and Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude, at Sea Level.	Equivalent of C° in Fahrenheit degrees.
136	2423.160	3.3843820	46.85653	1.6707702	276.8
7	2494.230	3.3969365	48.23080	1.6833246	278.6
8	2567.000	3.4094259	49.63800	1.6958140	280.4
9	2641.440	3.4218408	51.07740	1.7082289	282.2
140	2717.63	3.4341903	52.55060	1.7205784	284.0
1	2795.57	3.4464704	54 05780	1.7328585	285.8
2	2875.30	3.4586832	55.59955	1.7450713	287.6
3	2956.86	3.4708307	57.17665	1.7572188	289.4
4	3040.26	3.4829108	58.78935	1.7692988	291.2
5	3125.55	3.4949265	60.43864	1.7813146	293.0
6	3212.74	3.5068755	62.12460	1.7932637	294.8
7	3301.87	3.5187600	63.84813	1.8051481	296.6
8	3392.98	3.5305813	65.60990	1.8169693	298.4
9	3486.09	3.5423387	67.41036	1.8287267	300.2
150	3581.23	3.5540322	69.25009	1.8404203	302.0
1	3678.43	3.5656625	71.12963	1.8520506	303.8
2	3777.74	3.5772321	73.05000	1.8636202	305.6
3	3879.18	3.5887399	75.01153	1.8751281	307.4
4	3982.77	3.6001852	77.01463	1.8865733	309.2
5	4088.56	3.6115704	79.06030	1.8979585	311.0
6	4196.59	3.6228965	81.14930	1.9092847	312.8
7	4306.88	3.6341628	83.28196	1.9205509	314.6
8	4419.45	3.6453682	85.45870	1.9317563	316.4
9	4534.36	3.6565160	87.68720	1.9429041	318.2
160	4651.62	3.6676043	89.94820	1.9539924	320.0
1	4771.28	3.6786349	92.26200	1.9650230	321.8
2	4893.36	3.6896071	94.62290	1.9759952	323.6
3	5017.91	3.7005229	97.03110	1.9869110	325.4
4	5144.97	3.7113829	99.48809	1.9977710	327.2
5	5274.54	3.7221846	101.9935	2.0085727	329.0
6	5406.69	3.7329314	104.5490	2.0193195	330.8
7	5541.43	3.7436218	107.1544	2.0300099	332.6
8	5678.82	3.7542581	109.8110	2.0406462	334.4
9	5818.90	3.7648409	112.5199	2.0512290	336.2
170	5961.66	3.7753672	115.2804	2.0617553	338.0
1	6107.19	3.7858414	118.0945	2.0722295	339.8
2	6255.48	3.7962606	120.9615	2.0826487	341.6
3	6406.60	3.8066276	123.8842	2.0930157	343.4
4	6560.55	3.8169402	126.8610	2.1033283	345.2
5	6717.43	3.8272032	129.8947	2.1135913	347.0
6	6877.22	3.8374130	132.9845	2.1238011	348.8
7	7039.97	3.8475708	136.1314	2.1339589	350.6
8	7205.72	3.8576774	139.3367	2.1440655	352.4
9	7374.52	3.8677338	142.6008	2.1541219	354.2
180	7546.39	3.8777393	145.9243	2.1641274	356.00
1	7721.37	3.8876943	149.3078	2.1740825	357.8
2	7899.52	3.8976007	152.7527	2.1839888	359.6
3	8080.84	3.9074566	156.2588	2.1938446	361.4

REGNAULT'S RESULTS.—*Concluded.*

Degrees Centigrade.	Regnault's Record of Pressure in Millimetres at Observatory.	Log. of Millimetres.	Millimetres reduced to lbs. per square inch at 45° Latitude and Sea Level t. 32° F.	Log. of lbs. per square inch at 45° Latitude, at Sea Level.	Equivalent of C° in Fahrenheit degrees.
184	8265.40	3.9172639	159.8278	2.2036520	363.2
5	8453.23	3.9270226	163.4560	2.2134108	365.0
6	8644.35	3.9367323	167.1544	2.2231205	366.8
7	8838 82	3.9463943	170.9158	2.2327824	368.6
8	9036.68	3.9560089	174.7418	2.2423970	370.4
9	9237.95	3.9655757	178.6339	2.2519638	372.2
190	9442.70	3.9750962	182.5930	2.2614843	374.0
1	9650.03	3.9845287	186.6023	2.2709168	375.8
2	9862.71	3.9939962	190.7145	2.2803843	377.6
3	10078.04	4.0033764	194.8784	2.2897645	379.4
4	10297.01	4.0127111	199.1127	2.2990992	381.2
5	10519.63	4.0220005	203.4176	2.3083885	383.0
6	10745.95	4.0312448	207.7940	2.3176329	384.8
7	10975.00	4.0404045	212.2230	2.3267926	386.6
8	11209.82	4.0495987	216.7637	2.3359868	388.4
9	11447.46	4.0587091	221.3590	2.3450972	390.2
200	11688.96	4.0677759	226.0287	2.3541640	392.0
1	11934.37	4.0767994	230.7743	2.3631875	393.8
2	12183.69	4.0857788	235.5955	2.3721670	395.6
3	12437.00	4.0947156	240.4937	2.3811037	397.4
4	12694.30	4.1036088	245.4692	2.3899969	399.2
5	12955.66	4.1124595	250.5230	2.3988476	401.0
6	13221.12	4.1212683	255.6562	2.4076564	402.8
7	13490.75	4.1300360	260.8700	2.4164241	404.6
8	13764.53	4.1387615	266.1643	2.4251496	406.4
9	14042.52	4.1474451	271.5399	2.4338332	408.2
210	14324.80	4.1560885	276.9980	2.4424766	410.0
1	14611.32	4.1646894	282.5385	2.4510775	411.8
2	14902.22	4.1732510	288.1636	2.4596391	413.6
3	15197.48	4.1817716	293.8730	2.4681597	415.4
4	15497.17	4.1902523	299.6680	2.4766404	417.2
5	15801.33	4.1986937	305.5497	2.4850818	419.0
6	16109.94	4.2070940	311.5173	2.4934821	420.8
7	16423.15	4.2154565	317.5738	2.5018446	422.6
8	16740.90	4.2237788	323.7180	2.5101669	424.4
9	17063.29	4.2320628	329.9521	2.5184509	426.2
220	17390.36	4.2403086	336.2768	2.5266967	428.0
1	17722.13	4.2485127	342.6921	2.5349041	429.8
2	18058.64	4.2566851	349.1991	2.5430732	431.6
3	18399.94	4.2648164	355.7990	2.5512045	433.4
4	18746.07	4.2729102	362.4920	2.5592983	435.2
5	19097.04	4.2809660	369.2783	2.5673541	437.0
6	19452.92	4.2889848	376.1602	2.5753729	438.8
7	19813.76	4.2969668	383.1377	2.5833549	440.6
8	20179.61	4.3049127	390.2120	2.5913008	442.4
9	20550.48	4.3128219	397.3837	2.5992100	444.2
230	20926.40	4.3206945	404.6530	2.6070826	446.0

MEAN PRESSURE (ABSOLUTE) MULTIPLIER, FOR ANY PRESSURE AND EACH ONE THOUSANDTH OF THE STROKE.

	0	1	2	3	4	5	6	7	8	9
.01	.05605	.06027	.06448	.06870	.07292	.07713	.08135	.08557	.08979	.09400
.02	.09822	.10193	.10564	.10934	.11305	.11676	.12047	.12418	.12788	.13159
.03	.13530	.13864	.14199	.14534	.14864	.15203	.15538	.15872	.16207	.16541
.04	.16876	.17186	.17497	.17797	.18108	.18428	.18738	.19049	.19359	.19669
.05	.19980	.20269	.20559	.20849	.21139	.21429	.21718	.22008	.22298	.22588
.06	.22878	.23152	.23426	.23700	.23974	.24249	.24523	.24797	.25072	.25346
.07	.25620	.25878	.26137	.26396	.26655	.26914	.27172	.27431	.27690	.27949
.08	.28208	.28454	.28701	.28947	.29194	.29440	.29686	.29933	.30179	.30426
.09	.30672	.30907	.31142	.31378	.31613	.31849	.32084	.32319	.32555	.32790
.10	.33026	.33251	.33476	.33701	.33926	.34152	.34377	.34602	.34827	.35052
.11	.35278	.35493	.35709	.35924	.36140	.36355	.36571	.36786	.37002	.37217
.12	.37433	.37631	.37840	.38049	.38257	.38466	.38675	.38883	.39092	.39300
.13	.39519	.39720	.39920	.40121	.40321	.40521	.40722	.40922	.41123	.41323
.14	.41524	.41719	.41913	.42108	.42302	.42497	.42691	.42886	.43081	.43275
.15	.43470	.43651	.43832	.44013	.44194	.44375	.44556	.44737	.44918	.45099
.16	.45280	.45461	.45642	.45823	.46004	.46185	.46366	.46547	.46728	.46909
.17	.47090	.47271	.47452	.47633	.47814	.47995	.48176	.48357	.48538	.48719
.18	.48888	.49055	.49222	.49389	.49556	.49723	.49890	.50057	.50224	.50391
.19	.50558	.50720	.50882	.51044	.51206	.51379	.51541	.51703	.51869	.52027
.20	.52180	.52340	.52500	.52660	.52820	.52980	.53140	.53300	.53460	.53620
.21	.53781	.53935	.54090	.54245	.54400	.54555	.54710	.54865	.55020	.55175
.22	.55330	.55478	.55026	.55774	.55922	.56070	.56218	.56366	.56514	.56662
.23	.56811	.56957	.57103	.57249	.57395	.57541	.57687	.57833	.57979	.58125
.24	.58271	.58408	.58546	.58784	.58922	.59060	.59198	.59366	.59474	.59612
.25	.59650	.59787	.59824	.59961	.60198	.60235	.60472	.60609	.60746	.60883
.26	.61021	.61156	.61291	.61425	.61560	.61695	.61829	.61965	.62099	.62234
.27	.62369	.62496	.62624	.62852	.62979	.63106	.63134	.63262	.63389	.63516
.28	.63444	.63769	.63896	.64021	.64148	.64274	.64399	.64525	.64651	.64777
.29	.64903	.65024	.65146	.65268	.65389	.65511	.65633	.65755	.65877	.65998
.30	.66120	.66238	.66356	.66474	.66592	.66710	.66828	.66946	.67064	.67182
.31	.67300	.67418	.67536	.67654	.67772	.67890	.68008	.68126	.68244	.68362
.32	.68480	.68591	.68704	.68815	.68927	.69039	.69140	.69253	.69364	.69476
.33	.69598	.69706	.69815	.69924	.70032	.70141	.70250	.70259	.70468	.70576
.34	.70685	.70791	.70898	.71004	.71111	.71217	.71323	.71429	.71536	.71642
.35	.71750	.71854	.71958	.72062	.72166	.72270	.72374	.72478	.72582	.72686
.36	.72791	.72889	.72988	.73087	.73186	.73285	.73384	.73483	.73582	.73681
.37	.73780	.73880	.73980	.74080	.74180	.74281	.74381	.74481	.74581	.74681
.38	.74782	.74877	.74973	.75068	.75164	.75260	.75355	.75451	.75546	.75642
.39	.75738	.75832	.75926	.76021	.76116	.76210	.76304	.76398	.76493	.76587
.40	.76680	.76769	.76858	.76947	.77036	.77125	.77214	.77303	.77392	.77481
.41	.77570	.77659	.77748	.77837	.77926	.78015	.78104	.78193	.78282	.78371
.42	.78460	.78543	.78626	.78709	.78792	.78875	.78958	.79041	.79124	.79207
.43	.79290	.79373	.79456	.79539	.79622	.79706	.79889	.79972	.80055	.80138
.44	.80122	.80204	.80287	.80371	.80454	.80537	.80619	.80702	.80785	.80868
.45	.80951	.81030	.81109	.81188	.81267	.81347	.81426	.81505	.81584	.81663
.46	.81742	.81817	.81892	.81966	.82041	.82116	.82191	.82266	.82340	.82415
.47	.82490	.82567	.82643	.82720	.82797	.82874	.82950	.83027	.83104	.83180
.48	.83257	.83325	.83394	.83462	.83530	.83599	.83667	.83735	.83803	.83872
.49	.83940	.84011	.84082	.84153	.84224	.84295	.84366	.84437	.84508	.84579
.50	.84650	.84722	.84795	.84867	.84940	.85012	.85084	.85157	.85229	.85302

MEAN PRESSURE MULTIPLIER.—*Concluded.*

	0	1	2	3	4	5	6	7	8	9
.51	.85374	.85437	.85501	.85564	.85627	.85691	.85754	.85817	.85880	.85944
.52	.86007	.86072	.86138	.86203	.86268	.86335	.86399	.86464	.86529	.86595
.53	.86660	.86720	.86781	.86841	.86901	.86962	.87022	.87082	.87142	.87203
.54	.87263	.87326	.87389	.87451	.87514	.87577	.87640	.87703	.87765	.87828
.55	.87891	.87950	.88009	.88068	.88127	.88186	.88245	.88304	.88363	.88422
.56	.88481	.88536	.88591	.88647	.88702	.88757	.88812	.88867	.88923	.88978
.57	.89033	.89091	.89149	.89206	.89264	.89322	.89380	.89438	.89495	.89553
.58	.89610	.89665	.89719	.89773	.89827	.89881	.89935	.89989	.90043	.90097
.59	.90151	.90202	.90253	.90303	.90354	.90405	.90456	.90507	.90557	.90608
.60	.90659	.90707	.90754	.90802	.90849	.90897	.90944	.90992	.91039	.91087
.61	.91134	.91184	.91234	.91284	.91334	.91385	.91435	.91485	.91535	.91585
.62	.91635	.91682	.91729	.91777	.91824	.91871	.91918	.91965	.92013	.92060
.63	.92107	.92151	.92195	.92238	.92282	.92326	.92370	.92414	.92457	.92501
.64	.92545	.92592	.92639	.92686	.92733	.92780	.92827	.92874	.92921	.92968
.65	.93015	.93059	.93103	.93147	.93191	.93235	.93279	.93323	.93367	.93411
.66	.93455	.93492	.93529	.93566	.93603	.94641	.93678	.93715	.93752	.93789
.67	.93826	.93868	.93910	.93953	.93995	.94037	.94079	.94121	.94164	.94206
.68	.94248	.94291	.94334	.94378	.94420	.94463	.94505	.94548	.94591	.94634
.69	.94677	.94708	.94740	.94771	.94803	.94834	.94865	.94897	.94928	.94960
.70	.94991	.95020	.95049	.95078	.95107	.95137	.95166	.95195	.95224	.95253
.71	.95282	.95323	.95363	.95404	.95445	.95486	.95526	.95567	.95608	.95648
.72	.95689	.95720	.95750	.95781	.95812	.95843	.95873	.95904	.95935	.95965
.73	.95996	.96024	.96052	.96080	.96108	.96136	.96163	.96191	.96229	.96257
.74	.96275	.96302	.96330	.96357	.96384	.96412	.96439	.96466	.96493	.96521
.75	.96548	.96576	.96603	.96631	.96658	.96686	.96713	.96741	.96768	.96796
.76	.96823	.96850	.96876	.96903	.96930	.96957	.96983	.97001	.97037	.97063
.77	.97090	.97115	.97140	.97166	.97191	.97216	.97241	.97266	.97392	.97317
.78	.97342	.97372	.97403	.97433	.97463	.97493	.97524	.97554	.97584	.97615
.79	.97645	.97665	.97684	.97704	.97723	.97743	.97763	.97782	.97802	.97821
.80	.97841	.97866	.97891	.97916	.97941	.97967	.97992	.98017	.98042	.98067
.81	.98092	.98106	.98121	.98135	.98150	.98164	.98178	.98193	.98197	.98212
.82	.98236	.98256	.98276	.98297	.98317	.98337	.98357	.98377	.98398	.98418
.83	.98438	.98456	.98474	.98492	.98510	.98528	.98545	.98563	.98581	.98599
.84	.98617	.98637	.98656	.98676	.98695	.98715	.98735	.98754	.98774	.98793
.85	.98813	.98830	.98848	.98865	.98882	.98900	.98917	.98934	.98951	.98969
.86	.98986	.98997	.99007	.99018	.99029	.99040	.99050	.99061	.99072	.99082
.87	.99093	.99110	.99127	.99144	.99161	.99179	.99196	.99213	.99230	.99247
.88	.99264	.99279	.99294	.99309	.99324	.99339	.99353	.99368	.99383	.99398
.89	.99413	.99426	.99439	.99451	.99464	.99477	.99490	.99503	.99515	.99528
.90	.99541	.99542	.99544	.99545	.99547	.99548	.99549	.99551	.99552	.99554
.91	.99555	.99572	.99590	.99607	.99625	.99642	.99659	.99677	.99694	.99712
.92	.99729	.99735	.99741	.99747	.99753	.99759	.99765	.99771	.99777	.99783
.93	.99789	.99793	.99797	.99801	.99805	.99809	.99812	.99816	.99820	.99824
.94	.99828	.99830	.99831	.99833	.99834	.99836	.99838	.99839	.99841	.99842
.95	.99844	.99851	.99859	.99866	.99874	.99880	.99887	.99895	.99902	.99911
.96	.99918	.99922	.99926	.99930	.99934	.99939	.99943	.99947	.99951	.99955
.97	.99959	.99961	.99963	.99965	.99967	.99970	.99972	.99974	.99976	.99978
.98	.99980	.99981	.99982	.99983	.99984	.99985	.99986	.99987	.99988	.99989
.99	.99990	.99991	.99992	.99993	.99994	.99995	.99996	.99997	.99998	.99999

STEAM USED EXPANSIVELY.

Data all Rankine's, entirely computed by author.

1 ÷ r. 1	r. 2	rpm ÷ pl. 3	pl ÷ rpm. 4	pl ÷ pm. 5	pm ÷ pl. 6 = K.
.01	100.00	5.605	.17842	17.8420	.05605
.02	50.00	4.911	.20362	10.1810	.09822
.03	33.34	4.511	.22168	7.3910	.13530
.04	25.00	4.219	.23702	5.9256	.16876
.05	20.00	3.996	.25025	5.0050	.19980
.06	16.67	3.814	.26221	4.3710	.22878
.07	14.29	3.661	.27314	3.9032	.25620
.08	12.50	3.526	.28361	3.5452	.28208
.09	11.11	3.408	.29346	3.2603	.30672
.10	10.00	3.303	.30279	3.0279	.33026
.11	9.09	3.209	.31163	2.8340	.35278
.12	8.34	3.119	.32061	2.6707	.37433
.13	7.69	3.039	.32095	2.5304	.39519
.14	7.14	2.965	.33728	2.4082	.41524
.15	6.67	2.899	.34489	2.3004	.43470
.16	6.25	2.830	.35335	2.2085	.45280
.17	5.88	2.769	.36115	2.1236	.47090
.18	5.56	2.718	.36790	2.0455	.48888
.19	5.26	2.659	.37603	1.9779	.50558
.20	5.00	2.610	.38300	1.9164	.52180
.21	4.76	2.560	.39063	1.8594	.53781
.22	4.55	2.517	.39722	1.8073	.55330
.23	4.35	2.471	.40465	1.7602	.56811
.24	4.17	2.430	.41154	1.7161	.58271
.25	4.00	2.397	.41719	1.6764	.59650
.26	3.84	2.347	.42610	1.6388	.61021
.27	3.70	2.310	.43287	1.6033	.62369
.28	3.57	2.273	.44000	1.5712	.63644
.29	3.45	2.238	.44686	1.5408	.64903
.30	3.34	2.204	.45363	1.5124	.66120
.31	3.23	2.171	.46060	1.4859	.67301
.32	3.13	2.140	.46729	1.4603	.68480
.33	3.03	2.109	.47416	1.4368	.69598
.34	2.94	2.079	.48102	1.4147	.70685
.35	2.86	2.050	.48781	1.3937	.71750
.36	2.78	2.022	.49456	1.3738	.72791
.37	2.70	1.994	.50149	1.3554	.73780
.38	2.63	1.968	.50814	1.3372	.74782
.39	2.56	1.942	.51493	1.3204	.75738
.40	2.50	1.917	.52165	1.3041	.76680
.41	2.44	1.892	.52857	1.2891	.77570
.42	2.38	1.868	.53529	1.2745	.78460
.43	2.33	1.847	.54128	1.2612	.79290
.44	2.27	1.819	.54982	1.2481	.80122
.45	2.22	1.797	.55646	1.2353	.80951
.46	2.17	1.774	.56376	1.2233	.81742
.47	2.13	1.757	.56914	1.2123	.82490
.48	2.08	1.732	.57746	1.2011	.83257
.49	2.04	1.712	.58398	1.1913	.83940

STEAM USED EXPANSIVELY.—*Concluded.*

1 ÷ r. 1	r. 2	rpm ÷ pl. 3	pl ÷ rpm. 4	pl ÷ pm. 5	pm ÷ pl. 6 = K.
.50	2.00	1.693	.59067	1.1813	.84650
.51	1.96	1.673	.59760	1.1713	.85374
.52	1.92	1.651	.60558	1.1627	.86007
.53	1.89	1.638	.61055	1.1539	.86660
.54	1.85	1.614	.61945	1.1460	.87263
.55	1.82	1.599	.62516	1.1378	.87891
.56	1.79	1.584	.63140	1.1302	.88481
.57	1.75	1.558	.64182	1.1232	.89033
.58	1.72	1.541	.64880	1.1159	.89611
.59	1.70	1.533	.65250	1.1093	.90151
.60	1.67	1.514	.66050	1.1030	.90659
.61	1.64	1.495	.66909	1.0973	.91134
.62	1.61	1.475	.67782	1.0913	.91635
.63	1.59	1.465	.68283	1.0857	.92107
.64	1.56	1.444	.69268	1.0806	.92545
.65	1.54	1.432	.69812	1.0751	.93015
.66	1.52	1.421	.70398	1.0700	.93455
.67	1.49	1.398	.71531	1.0658	.93826
.68	1.47	1.392	.71847	1.0566	.94248
.69	1.45	1.373	.72844	1.0562	.94677
.70	1.43	1.358	.73617	1.0527	.94991
.71	1.41	1.344	.74434	1.0495	.95282
.72	1.39	1.330	.75185	1.0451	.95689
.73	1.37	1.315	.76039	1.0417	.95996
.74	1.35	1.299	.76942	1.0387	.96275
.75	1.33	1.284	.77877	1.0357	.96548
.76	1.32	1.278	.78244	1.0328	.96823
.77	1.30	1.261	.79231	1.0300	.97090
.78	1.28	1.246	.80259	1.0273	.97342
.79	1.27	1.240	.80640	1.0241	.97645
.80	1.25	1.223	.81766	1.0221	.97841
.81	1.24	1.216	.82215	1.0195	.98092
.82	1.22	1.199	.83439	1.0180	.98236
.83	1.21	1.191	.83956	1.0159	.98438
.84	1.19	1.174	.85212	1.0410	.98617
.85	1.17	1.156	.86497	1.0120	.98813
.86	1.16	1.148	.87091	1.0103	.98986
.87	1.15	1.139	.87753	1.0092	.99093
.88	1.14	1.132	.88372	1.0074	.99264
.89	1.12	1.113	.89813	1.0059	.99413
.90	1.11	1.105	.90507	1.0046	.99541
.91	1.10	1.095	.91317	1.0045	.99555
.92	1.09	1.087	.91992	1.0027	.99729
.93	1.08	1.078	.92790	1.0021	.99789
.94	1.06	1.058	.94502	1.0017	.99828
.95	1.05	1.048	.95387	1.0016	.99844
.96	1.04	1.039	.96235	1.0008	.99918
.97	1.03	1.030	.97127	1.0004	.99959
.98	1.02	1.020	.98060	1.0002	.99980
.99	1.01	1.010	.99020	1.0001	.99990

TEMPERATURE OF STEAM AT EACH POUND (ABSOLUTE PRESSURE).

From 1 to 350+.

Regnault's Observations, Dixon's Translations of C° to F° and Pounds, Author's Computation. For Ordinary Computations in Steam Gauge Pressure, Deduct 15 from Absolute.

Abs. Pressure in lbs. per sq. in.	F°	Abs. Pressure in lbs. per sq. in.	F°	Abs. Pressure in lbs. per sq. in.	F°	Abs. Pressure in lbs. per sq. in.	F°
1	102.041	48	278.291	94	323.131	140	352.766
2	126.310	9	279.584	5	323.887	1	353.314
3	141.628			6	324.629	2	353.866
4	153.066	50	280.849	7	325.382	3	354.411
5	162.337	1	282.104	8	326.111	4	354.958
6	170.132	2	283.321	9	326.848	5	355.508
7	176.929	3	284.535			6	356.031
8	182.919	4	285.719	100	327.576	7	356.566
9	188.326	5	286.896	1	328.284	8	357.111
		6	288.047	2	329.002	9	357.633
10	193.301	7	289.114	3	329.711		
1	197.769	8	290.312	4	330.423	150	358.166
2	201.958	9	291.421	5	331.117	1	358.688
3	205.889			6	331.814	2	359.205
4	209.610	60	292.526	7	332.498	3	359.722
5	213.036	1	293.594	8	333.177	4	360.239
6	216.298	2	294.659	9	333.859	5	360.744
7	219.428	3	295.710			6	361.256
8	222.414	4	296.756	110	334.528	7	361.762
9	225.213	5	297.779	1	335.199	8	362.277
		6	298.788	2	335.857	9	362.776
20	227.919	7	299.791	3	336.521		
1	230.511	8	300.777	4	337.166	160	363.278
2	233.014	9	301.756	5	337.821	1	363.777
3	235.433			6	338.462	2	364.272
4	237.757	70	302.721	7	339.108	3	364.771
5	240.070	1	303.673	8	339.733	4	365.261
6	242.185	2	304.617	9	340.364	5	365.739
7	244.289	3	305.552			6	366.236
8	246.336	4	306.474	120	340.991	7	366.721
9	248.316	5	307.388	1	341.621	8	367.202
		6	308.294	2	342.242	9	367.684
30	250.254	7	309.186	3	342.858		
1	252.118	8	310.072	4	343.468	170	368.162
2	253.942	9	310.945	5	344.077	1	368.636
3	255.726			6	344.673	2	369.109
4	257.470	80	311.814	7	345.281	3	369.576
5	259.172	1	312.672	8	345.877	4	370.045
6	260.829	2	313.524	9	346.455	5	370.514
7	262.451	3	314.359			6	370.982
8	264.039	4	315.200	130	347.056	7	371.448
9	265.599	5	316.009	1	347.641	8	371.914
		6	316.843	2	348.229	9	372.367
40	267.124	7	317.651	3	348.811		
1	268.614	8	318.455	4	349.388	180	372.824
2	270.071	9	319.252	5	349.954	1	373.277
3	271.511			6	350.523	2	373.737
4	272.921	90	320.042	7	351.091	3	374.188
5	274.294	1	320.819	8	351.755	4	374.639
6	275.654	2	321.596	9	352.214	5	375.088
7	276.995	3	322.369			6	375.536

TEMPERATURE OF STEAM AT EACH POUND.—*Concluded.*

Abs. Pressure in lbs. per sq. in.	F°	Abs. Pressure in lbs. per sq. in.	F°	Abs. Pressure in lbs. per sq. in.	F°	Abs. Pressure in lbs. per sq. in.	F°
187	375.978	229	393.156	270	407.669	312	420.860
8	376.416			1	408.020	3	421.161
9	376.843	230	393.533	2	408.346	4	421.462
		1	393.913	3	408.682	5	421.762
190	377.299	2	394.283	4	409.004	6	422.078
1	377.729	3	394.662	5	409.332	7	422.349
2	378.163	4	395.036	6	409.671	8	422.632
3	378.591	5	395.405	7	410.008	9	423.034
4	379.021	6	395.770	8	410.321		
5	379.457	7	396.141	9	410.662	320	423.292
6	379.983	8	396.510			1	423.574
7	380.310	9	396.888	280	410.976	2	423.758
8	380.729			1	411.282	3	424.092
9	381.160	240	397.252	2	411.610	4	424.402
		1	397.612	3	411.924	5	424.664
200	381.576	2	397.964	4	412.244	6	425.009
1	381.994	3	398.340	5	412.559	7	425.228
2	382.408	4	398.688	6	412.878	8	425.517
3	382.821	5	399.061	7	413.201	9	425.804
4	383.240	6	399.412	8	413.524		
5	383.660	7	399.762	9	413.848	330	426.092
6	384.070	8	400.131			1	426.373
7	384.480	9	400 482	290	414.162	2	426.712
8	384.894			1	414.472	3	427.009
9	385.287	250	400.832	2	414.788	4	427.279
		1	401.181	3	415.093	5	427.490
210	385.671	2	401.532	4	415.409	6	427.832
1	386.122	3	401.884	5	415.723	7	428.113
2	386.522	4	402.141	6	416.018	8	428.394
3	386.922	5	402.581	7	416.322	9	428.682
4	387.326	6	402.928	8	416.642		
5	387.724	7	403.282	9	416.959	340	429.011
6	388.162	8	403.640			1	429.286
7	388.512	9	403.972	300	417.268	2	429.555
8	388.904			1	417.560	3	429.822
9	389.196	260	404.311	2	417.859	4	430.093
		1	404.657	3	418.159	5	430.376
220	389.584	2	404.993	4	418.461	6	430.682
1	390.071	3	405.322	5	418.759	7	430.998
2	390.460	4	405.676	6	419.059	8	431.274
3	390.858	5	406.002	7	419.362	9	431.552
4	391.241	6	406.334	8	419.681		
5	391.633	7	406.666	9	420.028	350	431.830
6	391.992	8	407.013			350.647	432
7	392.390	9	407.334	310	420.320		
8	392.823			1	420.540		

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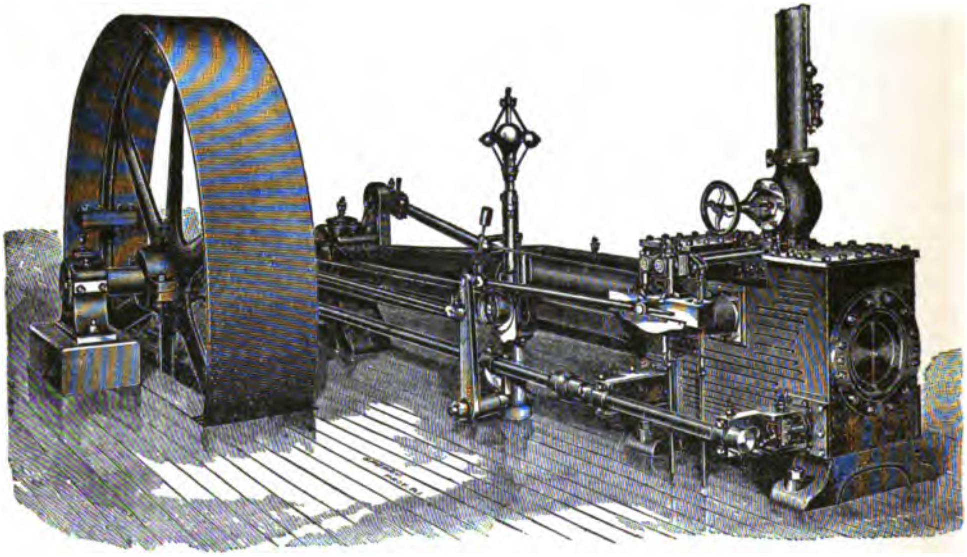

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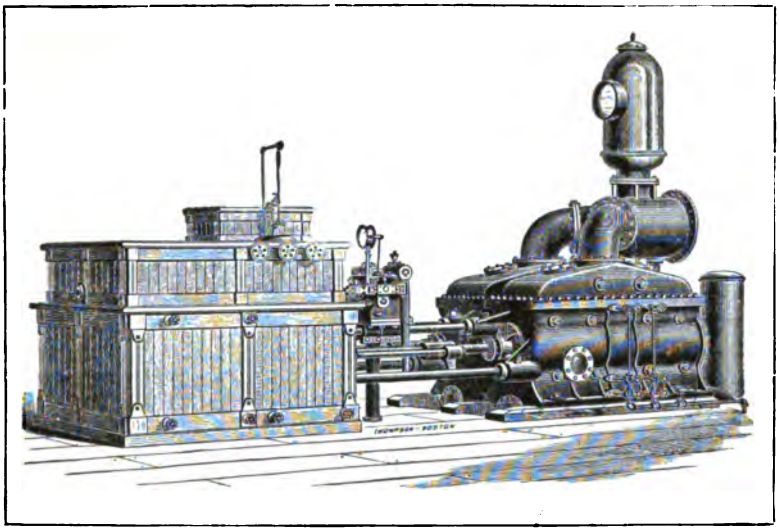

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